PRACTICAL ENGINEER

Trade-mark reg. U. S. Pat. Office

SEMI-MONTHLY

VOL. XVIII. CHICAGO, NOVEMBER 1, 1914 No. 21

Plant of the West Virginia Traction & Electric Co.

MORGANTOWN PUBLIC SERVICE COMPANY'S PLANT CONTAINING GAS-FIRED BOILERS; WESTINGHOUSE AUTOMATIC ENGINES AND LOW-PRESSURE TURBINE USED AS PRIME MOVERS. BY C. E. NIGH

THE WEST VIRGINIA TRACTION & ELECTRIC CO., Morgantown, W. Va., owns and operates 3 distinct enterprises: street railway light and power system, water supply system and the natural gas system of the city.

Located near the central part of the city and constructed of steel, red brick and concrete, with a tile roof and divided into a boiler and engine room by a brick fire wall, is the electric power station. Figure 1 shows the outside of the station, which is almost covered by a creeping vine, giving it a pleasing appearance. The engine room, the floor of which is of concrete except around the turbine unit, where grating is used, is well lighted and ventilated and a 12-ton crane hand operated runs the length thereof.

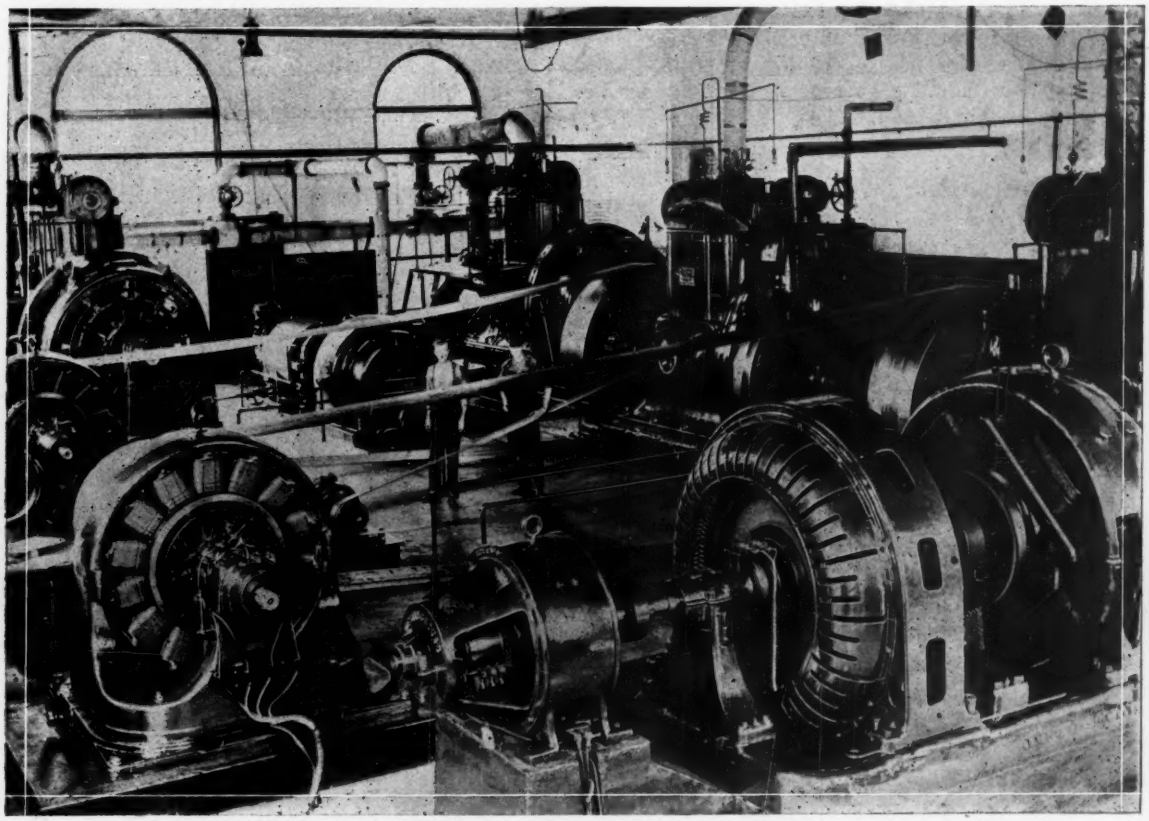

FIG. 4. GENERAL VIEW OF ENGINE ROOM

Boiler Room

In the boiler room are 4 Stirling water-tube boilers, 300-hp. each, and fired with natural gas supplied through an 8-in. pipe passing in front of the boilers under the floor. Branch headers extend along the sides of each battery of boilers, and 1½-in. pipe connections pass through the side of the setting under the ash-pit floor and up on each to where they are connected to 5-in. Kirkwood burners set in a vertical position as shown in sectional plan view, Fig. 2. An automatic pressure

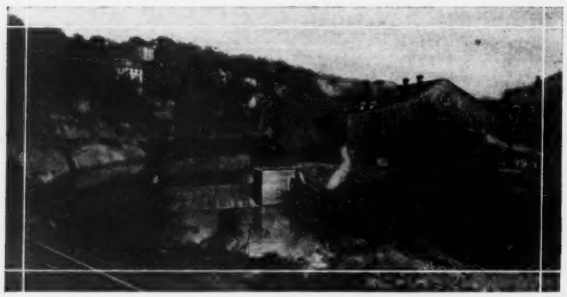

FIG. 1. POWER HOUSE AND DAM; W. VA. TRACTION AND ELECTRIC CO.

regulating valve is placed in the 8-in. gas main just inside the boiler room and controlled by the steam pressure, which seldom varies over 5 lb. on changes of load, with a gas pressure of 2¾ oz. at the burners. The boilers are equipped with feed water regulators, and are supplied by 2 9 by 10-in. duplex Platt Iron Works pumps taking water by gravity from an open feed water heater at an average temperature of 210 deg. F. These pumps are equipped with pump governors, making the boiler operation almost automatic.

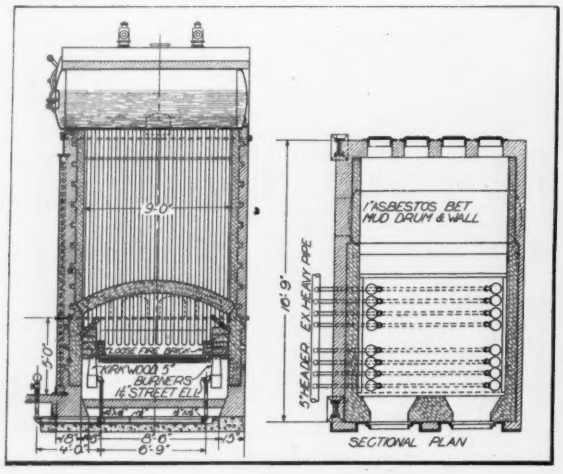

FIG. 2. SHOWING LOCATION OF GAS BURNERS UNDER STIRLING BOILERS

Pumps, heater and steel supports for the steel stack and the induced draft outfit are in the rear of the boilers. The 7-ft. diameter steel stack 25 ft. high above the boilers is connected to a common smoke flue above and at the rear of the boilers, also a connection between the smoke flue and the 10-ft. fan, which is driven by a 10 by 12-in. B. F. Sturtevant simple engine. All water and gas used in the plant is metered in gallons and cubic feet. These meters are read every 6 hr. Steam pressure carried is 150 lb. gage. Figure 3 illustrates the boiler room.

Piping

The main steam header, 12 in. diameter, is above the rear part of the boilers, supported from the steel work of the roof and by the framework of the boilers, and

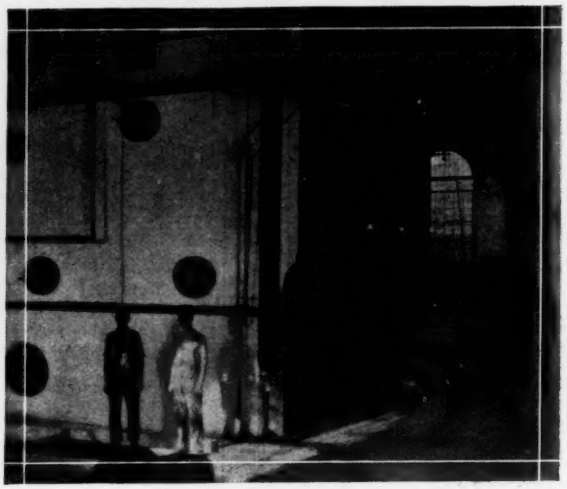

FIG. 3. BOILER ROOM

connected thereto by 8-in. long-radius bends with a gate valve next to the header and one next to the boiler. One end of the header drops down 6 ft., is reduced to 10 in. and extended across one end of the engine room, where it connects to 2 of the engines and the turbine as shown in Fig. 4, an interior view of the engine room.

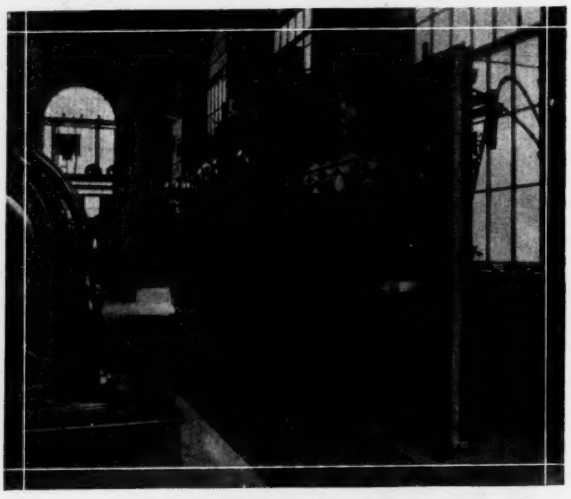

FIG. 5. SWITCHBOARD

The other 2 engines are connected to the main header by long-radius bends passing through the wall between the engine and boiler rooms. The pumps and fan engine are supplied by a separate steam header which is connected to the boilers direct by 1½-in. lines. All high

pressure piping and fittings are extra heavy and well insulated; condensation is returned to the boilers by a Holly gravity return system.

Engine Room

Original installation consisted of 4 Westinghouse automatic compound engines, 2 18 by 30 by 16-in. direct connected to 200-kw. d.c. generators of the same make for street railway service, 2 16 by 27 by 16-in. belted to a.c. generators of the same make, 180-kw., 2-phase, 2200-v. and to 5.6-kw. exciters. In January, 1912, a 625-kv.a. Westinghouse-low pressure turbine was installed between the 2 d.c. units, as seen in Fig. 4, and a 15-kw. motor generator exciter set shown in Fig. 5 with view of the switchboard.

All engines exhaust into a common header, which contains a receiver separator which separates oil and moisture from the exhaust steam before it enters the turbine. Steam pressure at the turbine throttle is 3 lb. gage or less, all excess exhaust steam passing through an automatic relief valve to the feed water heater, and in case of insufficient exhaust steam the turbine governor operates an auxiliary valve admitting live steam to the turbine at reduced pressure.

Condensing Apparatus

Directly beneath the turbine and discharging into its top is a No. 10 Westinghouse LeBlanc condenser, with centrifugal circulating and air pumps, steam turbine driven at 1500 r.p.m. This turbine exhausts direct into the feed water heater and with the exhaust from the feed pumps furnishes sufficient steam to heat the feed water when the large turbine is using all the exhaust steam from the engines.

Condensing water is supplied through a 12-in. line at about 7 ft. lift from a creek passing the plant, across which a concrete dam was built to form a storage and cooling pond. The water from the condenser can be discharged above or below the dam, so in time of a drouth the water is discharged above the dam and must travel

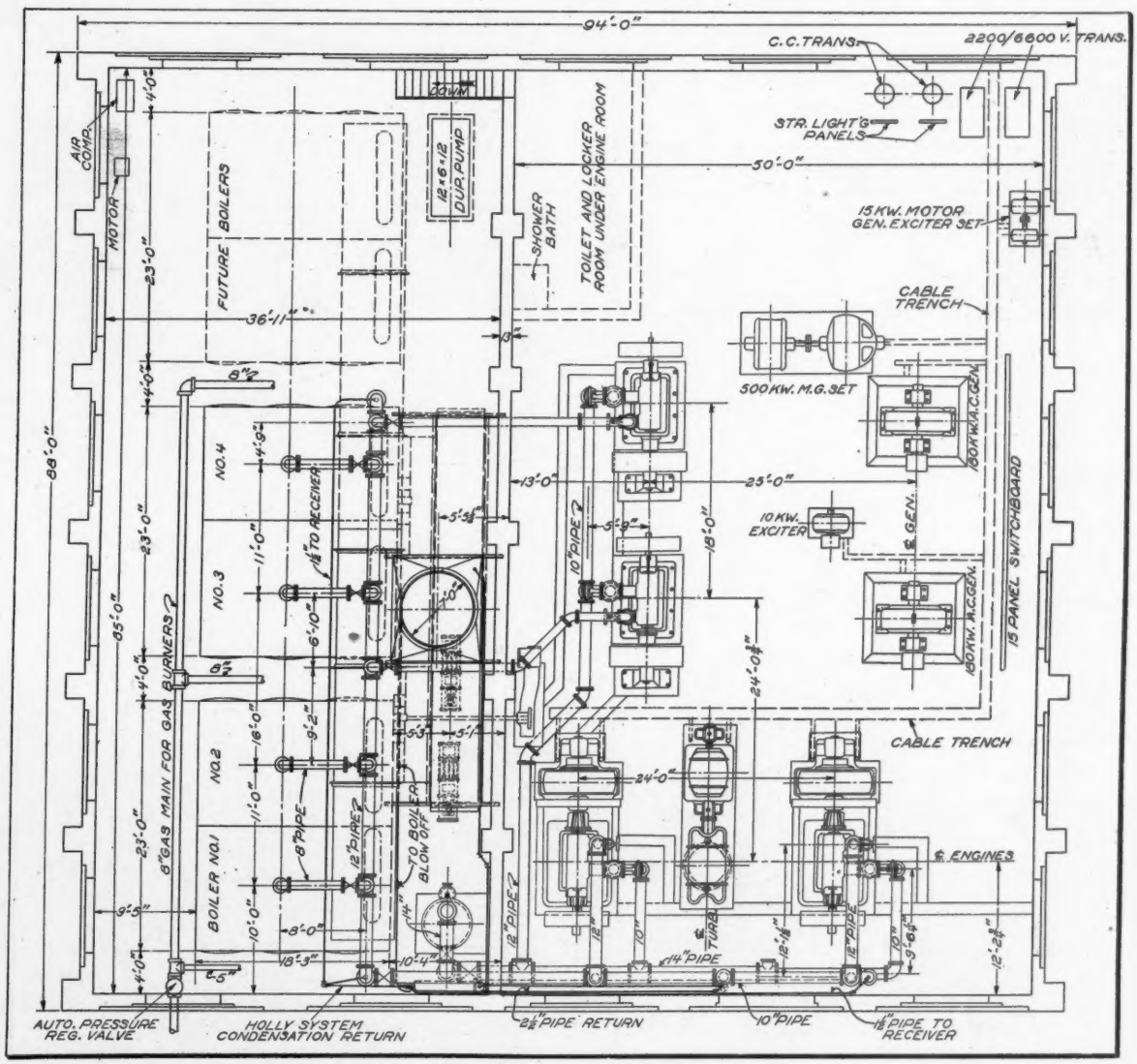

FIG. 6. PLAN OF POWER STATION

West Virginia Traction & Electric Co.
MORGANTOWN DIVISION.

POWER STATION REPORT	Month of	191
Gas,	Cu. ft.	
Water,	Gals.	
Loop and Feeders,	K. W.	
Sabraton Railway,	K. W.	
Total D. C.,		
Incandescent Light Circuit,	K. W.	
Arc Light Circuit,	K. W.	
Commercial Light Circuit,	K. W.	
High Tension Circuit,	K. W.	
Commercial Motor Circuit,	K. W.	
Total A. C.,	" "	
Grand Total,	" "	
A. C. Charge,	%	
D. C. Charge,	%	
Gas per K. W. Hour,	Cu. ft.	
Water per K. W. Hour,	Gals.	
Water per Cu. ft. Gas,	Lbs.	
Crank Case Oil used,	Gals.	
Cylinder " "	"	
Engine " "	"	
Turbine " "	"	
" "	"	
Boiler Compound "	"	
Waste "	"	

Engineer.

FIG. 7. MONTHLY POWER STATION REPORTS

West Virginia Traction & Electric Co.
Morgantown Branch
OIL AND WASTE RECORD

Station. Month of 19

	Crank Case Oil	Cylinder Oil	Engine Oil	Turbine Oil	Air Comp. Oil	Arctic Machine Oil					Grease	Waste
Gallons on Hand												
Gallons Received												
Total												
Taken Out Date	Quarts	Quarts	Quarts	Quarts	Quarts	Quarts						
1												
2												
3												
4												
5												
6												
7												
8												
9												
10												
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25												
26												
27												
28												
29												
30												
31												
Total Out												
Balance on Hand												

Remarks:

Engineer.

FIG. 8. MONTHLY OIL AND WASTE RECORDS

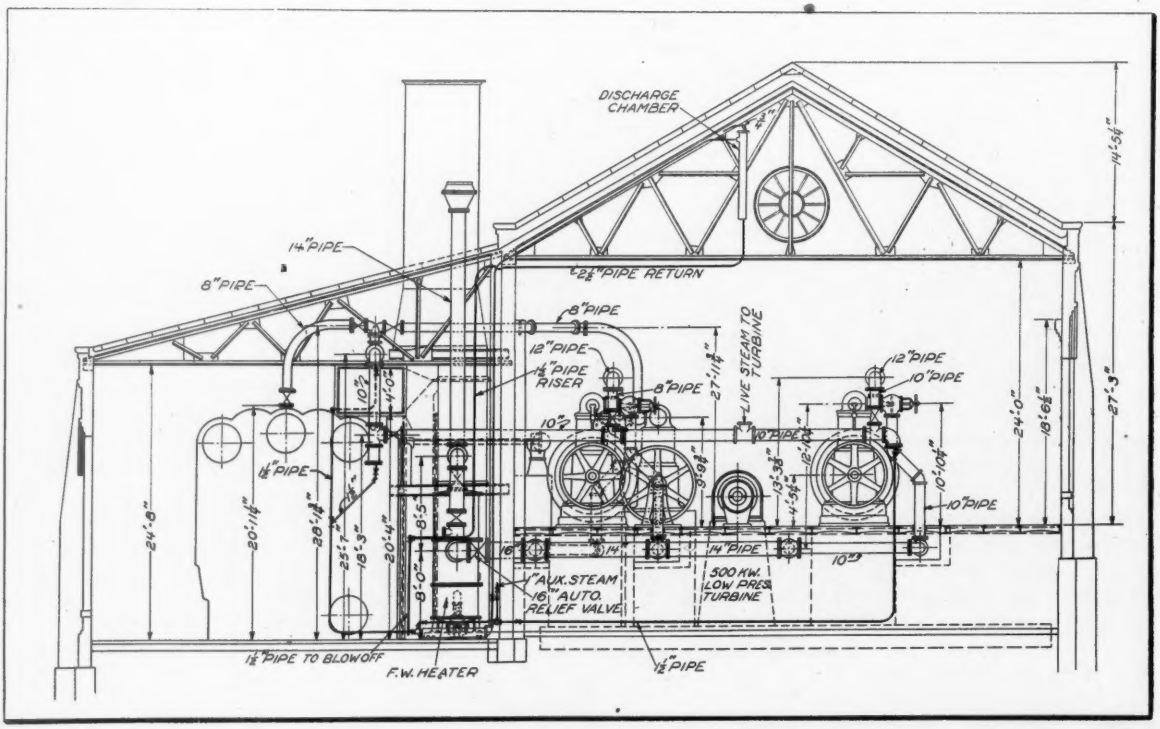


FIG. 6A. SECTIONAL ELEVATION OF STATION

800 ft. before it can be used again, as the intake to the well that supplies the condenser is 800 ft. up stream and connected with the well by a 20-in. sewer-pipe line, giving sufficient cooling area in traveling this distance. Figure 1 gives a view of the dam.

ELECTRICAL

THE TURBO generator is of 3-phase and rated at 6600 v., 3600 r.p.m., and operates in parallel with the other a.c. generators through 2 oil cooled 2200/6600-v. transformers. From the turbine side of the transformers a 3-phase, 6600-v. circuit supplies current to several industrial plants and a 200-kw. rotary converter at a coal mine about 3 miles distant. In 1910 a 180-kw. motor-generator set was installed, 2-phase, 2200-v., a.c. end, 600-v. d.c. end, and operated as a connecting link between the a.c. and the d.c. systems; and was so adjusted that either system could help out the other as load changes demanded. In April, 1912, this set was replaced by a 500-kw. set and is operated under same conditions. Later, a 35-kw. exciter unit was connected to this set, as shown in Fig. 4. This set is started from the d.c. side.

The 15-panel switchboard shown in Fig. 5 is well equipped with instruments, each a.c. generating unit with an indicating wattmeter, an ammeter and a power factor meter; for the a.c. end of the motor-generator set a frequency meter is included, and on the turbo generator panel a graphic wattmeter. Two a.c. voltmeters are provided, one on bus, the other through plug receptacles to connect to any incoming a.c. generator. Synchronizing lamps (dark) are used in paralleling alternators. Recording a.c. and d.c. voltmeters and a recording vacuum gage are provided, and each a.c. feeder circuit is provided with an oil circuit breaker and a recording watthour meter. A Tirrill voltage regulator maintains a steady voltage on the system. Each d.c. feeder is supplied with a circuit breaker and an ammeter, and all the current is metered by 2 Thomson recording wattmeters.

All electric meters are read hourly and a system of daily and monthly records is kept. All d.c. current is used for street car service; the a.c., for commercial, street lighting and industrial motors.

Figure 6 is a cut illustrating the plan and sectional view of The W. Va. Traction & Electric Co.'s power station, while Figs. 7 and 8 are reproductions of the monthly station and monthly oil and waste reports used at this plant.

The Injector Condenser

BY RECEIVER

THE advantage of this condenser, which is called the injector or barometric, is its simplicity, low first cost, and low cost of operation. In the majority of the installations, these condensers are so located that the hot well will drain itself without the use of an air pump, and this still further reduces the cost of operation. Because the pressure of the atmosphere will theoretically support a column of water 33.44 ft. high, and there is some vapor tension in the upper part of the condenser to be taken care of, it is necessary to locate the condenser so that the cone is at a height of 35 ft. from the top of the overflow of the hot well; the weight of the water column in the discharge or tail pipe 2, will then overbalance the pressure of the atmosphere, the water will fall into the hot well, and this will, in turn, lift water from the source of supply into the cone.

Installations in which the cone is at an altitude of more than 20 ft. from the surface of the source of supply, will require the injection water to be raised by a pump, and for this purpose, a light service reciprocating pump, or a centrifugal pump for low head, makes a good apparatus. If the condenser can be so located that the cone is 20 ft. or less from the level of the source of supply, tees 3, 3, may be set in the tail pipe and the draft pipe and connected with a valve, 4, as shown, this being called a center or starting valve. It should, if possible, be located about 17 ft. from the overflow of the hot well. It is necessary that the distance of the hot well overflow below the level of the source of supply be greater than the distance from the source up to the injection ring, if the falling water is to create a vacuum sufficient to raise the water into the condenser.

In some plants, the hot well is a cast-iron tank, in others a brick, cement-lined chamber; but whatever the construction, great care must be taken to make certain that its volume is at least equal to 4 times that of the discharge pipe, and that the tail pipe is sealed by at least 18 in. of water above the outlet, yet the end must clear the bottom of the well by 6 in. If the hot well volume is too small, the vortex that the water makes, due to air when starting, may uncover the end of the tail pipe, and the atmosphere force water into the cylinder, if the height of the condenser is lower than it should be.

Where the water must be removed from the hot well by a pump, the well should overflow into another compartment, and the pump take water from that, so that there is no danger of lowering the level in the hot well and uncovering the tail pipe.

Large volumes of air enter the condensing system, some from the boilers with the steam, some from leaks, and some with the injection water. Due to the action of the condenser, this air is carried downward through the contracted neck, 5, which acts as a sort of trap and prevents its return. The tendency of these air bubbles is to rise in the tail pipe after passing the neck, so that it is necessary for the water column to be maintained at a velocity sufficient to carry the air into the hot well, and this is one of the factors in determining the amount of water that must be delivered into the condenser.

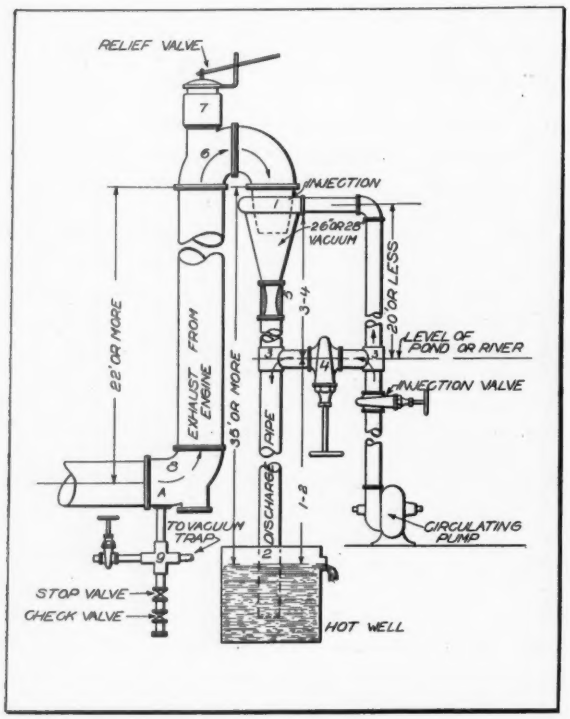
In the suction pipe, there should be a reliable strainer or screen, placed in an accessible location so that it can be cleaned, the twin type of strainer being preferable.

On top of the elbow, 6, is a relief valve, 7, which opens automatically when the vacuum is lost, and allows exhaust steam to escape into the air. In the clapper of this relief valve, a groove is turned and a rubber ring forced into this; this, due to the hammering on the seat

when starting and stopping or when the vacuum is broken, becomes, in time, injured and leaks, so that it must be replaced.

To support the weight of the exhaust pipe on the condenser, a slight foundation is required under the chair elbow, 8, and, of course, if a pump is necessary, that must have a substantial support. The tail pipe is held by a clamp on a beam of metal that rests on the hot well, and provision must be made for the support of this beam; also, if the hot well is covered, it must be amply vented to the atmosphere.

Care should be taken that the drip connected at A on the chair elbow, 8, is of ample size, and that it is kept clear from clogging with oil. The writer always



INJECTOR OR BAROMETRIC CONDENSER

pipes this drip, as shown in the illustration, having a nipple from the boss on the casting, 8, which is connected into a cross, 9.

One outlet of this cross has a nipple, valve, and check valve, the check swinging so that when there is vacuum in the system, the atmospheric pressure holds the valve closed. To one branch of the cross, a reliable vacuum trap is connected, because large volumes of water will be present in the system, and while they may be swept into the condenser, it is better to remove them with the trap, whose operation can be adjusted so as not to impair the vacuum.

To maintain a satisfactory vacuum, leakage must be kept at a minimum, which requires that all stuffing boxes be carefully packed and taken up periodically, and all valve bonnets on the system should receive careful attention. Also, the vacuum breaker must be watched.

This vacuum breaker is a pipe connected anywhere in the system, between the exhaust from the prime mover and the condenser, above the line at which any water could collect, and is controlled by a valve within easy reach of the engineer. All piping and joints should be painted with asphaltum paint, to seal any pores in the metal. A good way to test for leaks, is to go carefully over all piping, fittings and joints, when vacuum is on the system, with a lighted candle, and watch for places where the flame from the candle is drawn in. Even more satisfactory is blocking the relief valve to its seat, blanking off the discharge pipe into the hot well, and subjecting the whole system to a pressure of about 30 lb., which will show up the leaks in good shape. Often a leak around an indicator cock or connection to a vacuum gage will cause trouble, and these points should be looked after.

Starting Up

Some engineers prefer to start the condenser, then warm up the prime mover, and start it exhausting into the condenser; but the writer prefers to warm up the unit without vacuum, so that the entire exhaust line is heated to normal temperature, and no great volume of condensation is formed at the moment of starting. Having the unit warmed up, close the vacuum breaker valve, and if a pump is necessary to supply water to the condenser, start it, which will establish vacuum in the system, and the unit may then be brought up to speed, condensing from the start, or the unit may be started, and when up to full speed, the circulating pump put into operation, and when the vacuum is established, the condenser will take its load, the vacuum being regulated by the speed of the circulating pump. In either case, the drain check will seat and remain closed, as soon as a slight vacuum is created, and this prevents forgetting to open the drain on the exhaust line, which would allow water to accumulate in the exhaust pipe. This drain check valve should be cleaned frequently to prevent the gathering of oil on the seat, which would cause leakage.

When the condenser can be located so that the starting valve, 4, can be used, the main injection valve is opened when it is desired to start the condenser; then the starting valve is opened, which will allow water under pressure to pass from the suction to the tail pipe, driving out the air, condensing the steam, and creating a partial vacuum. When the vacuum gage shows 10 in. or so, gradually close the starting valve, and let it remain closed while running. Should the vacuum break, open the starting valve, and when sufficient vacuum is obtained, close it again. Inspection of the elbow on top of the condenser should be made at least twice a year, to make sure that no dirt has gathered between the cone and the casting, as such an accumulation will cut down the vacuum until it is removed.

To shut down a unit which exhausts into this style of condenser, some engineers trip the throttle, then the injection valve, if no pump is used, or if a pump is used, shut down the pump, and then break the vacuum and open the drip. Others stop the pump or close the injection valve, then break the vacuum and open the drip, and lastly, close the throttle to the engine. Either way is satisfactory, if the proper sequence is followed.

Loyalty is that quality which urges us to be true to whatever we undertake in life. To be steadfast; true to ourselves and to others.

Economy for the Steam Laundry

METHODS OF BALANCING HEAT AND POWER LOAD. BY STERLING H. BUNNELL

GROWTH of the steam laundry business is nothing less than astonishing. Several large corporations make exclusive specialties of ingenious and effective machines for every detail of handling, washing, drying and finishing textile articles in enormous quantities. The connecting link between almost all the machines in the laundry is the steam pipe, and the driving power for all is the old reliable steam boiler engine; and yet, not one of the laundry machinery manufacturers has given the slightest attention to designing an economical steam plant for the laundry.

The usual course of fitting up a steam laundry commences with the purchase of the laundry machines, generally in a single order from one manufacturer. The price and terms of payment for this transaction being arranged, the laundry owner makes a guess at the size of boiler he needs and proceeds to hunt up and purchase a second-class or secondhand boiler, engine and water heater. He installs these by day labor, has the pipe connections run by a local workman, without a plan, and omits pipe covering to save its purchase price. The laundry machine equipment, being designed and installed by a specialist, is almost perfection. The steam plant, being picked up and thrown together by guess, is usually so badly balanced, wasteful and expensive to run, that the owner of a laundry begins apologizing for it as soon as the visitor enters the building.

Every establishment requiring heat and power together gives to the practical engineer an opportunity to save money by applying steam engineering principles. Heating to uniform temperatures can be done in most cases by steam at suitable pressures. Power and heat together always suggest the steam engine and its hot exhaust.

Whatever the relative amounts of power and heat that may be wanted for any special purpose, steam produced in a boiler at a proper pressure can be expanded in an engine and exhausted at the pressure and temperature required for the heating portion of the work. The efficiency of the combined operation is remarkably good. Steam heating may be as high as 95 per cent efficient. Steam power development, where the heat carried off in the exhaust is useful, and so not a waste, but a valuable byproduct, is also very efficient. Fuel used in producing steam under pressure may develop an efficiency as high as 80 per cent, and should not do less than 60 per cent. Therefore, to produce a quantity of heat at 212 deg., and a quantity of power as well, it is necessary only to provide sufficient steam at a pressure sufficiently high to produce the necessary horsepower when expanded in a steam engine and exhausted at atmospheric pressure, and the necessary heat when condensing to water at 212 deg.

For example, suppose that a steam laundry requires 3000 gal. of water an hour, heated from 60 up to 180 deg., and 4000 lb. an hour of steam at about 5 lb. pressure, for the various machines and driers; and 75 hp. of mechanical work. The steam needed to heat the water is $3000 \times 8\frac{1}{3} \times (180 - 60) \div 966 = 3104$ lb. an hour.

The total quantity of steam required for heat is, therefore, 7104 lb., or 237 hp. If the steam is to go through an engine before being used for heat, some of it will condense to water in the process. It will be necessary to make an allowance for this loss, which may be placed at 15 per cent under the conditions toward which we are working. The total boiler horsepower capacity provided for should therefore be $237 \div 0.85 =$ 280 hp. nearly.

To get only 75 hp. out of 280×30 lb. of steam per hour requires but little pressure. An initial pressure of 100 lb. with a cutoff giving a mean effective pressure of 40 lb., would produce (at 30 lb. per hp.-hr.) 280 hp. A mean effective pressure of $75 \times 40 \div 280 = 11$ lb. nearly, will be sufficient; and as a low initial pressure in the engine makes a late cutoff necessary, a boiler pressure of 20 lb. gage would be sufficient.

With the relative amounts of power and heat assumed above, there is evidently no reason for carrying much boiler pressure, except to the extent of avoiding freak conditions. If 50 lb. pressure is carried, however, the engine could not possibly pass through more than ⅓ of the steam required for other purposes. But as it costs only 10 to 15 per cent more in coal to put the steam pressure from 212 deg. up to usual working figures, the plant will in effect produce a horsepower for only 10 to 15 per cent of the usual cost of coal, where the coal is burned for power only. This fact puts the owner of the plant in position to produce extra power very cheaply, and makes it worth while to find some way to increase his power load, or sell power to outside parties at profitable figures.

Every steam laundry can therefore become a commercial power plant, and, producing power at a fraction of the usual cost, can sell it at a correspondingly large profit. The terms of sale of power ought to cover its use during laundry running hours only, when all the exhaust steam will be needed for the laundry work; and there will be no steam available for sale for heating purposes. Power can be provided at other times at whatever cost is appropriate to the equipment; and the whole amount of power sold can be charged under a flat rate, if this is high enough to cover the average cost. Thus, if a fuel cost of 1 cent per horsepower-hour is reasonable for a small steam power plant under the local conditions, the fuel cost of steam power furnished from steam afterwards used in the laundry for heat, would be only 10 to 15 per cent of the total, and if power is to be sold over a period of 8 hr.laundry working time and 2 hr. time outside, the fuel cost may be taken as $(0.15 \times 8) + (2 \times 1) = 3.2$ cents, or at the flat rate of 0.32 cent per hour. If an average rough cost of 3 cents per horsepower-hour is reasonable under general local conditions, and the fuel cost is 1 cent, then the other expenses are 2 cents, and the cost of the power for sale outside may be taken as 2.32 cents per horsepower-hour. In the case proposed above, the owner of the laundry may figure that to run his boilers at 100 lb. steam pressure and produce for sale a surplus of

280 — 75 = 205 hp. during laundry hours would increase his coal bill only 15 per cent on the portion of the coal used for the extra 205 hp., or 205 × 15 ÷ 280 = 11 per cent nearly. At this cost, the laundry could under sell a big central station and make a good profit at that; but, in most cases, the price can be made at the market, and a large profit kept for the laundry.

Sale of power is a possible source of income for every laundry with standard equipment; but it is just as possible to build a laundry which will need all its power, in operating a balanced equipment. Many of the special ironing machines used in laundries are heated by gas flames. All of these can be heated better by electricity. Electric heat is more easily controlled than gas, does not heat the work-room to the same extent, nor vitiate the atmosphere like gas flames. Since electric power up to the limit of the steam needed for heat, is available at 10 to 15 per cent of the fuel cost in a plant of the same size run for power purposes only, the cost of current is trifling.

The general problem of the balanced laundry power plant commences with the apparatus which must use steam heat, like the water heater, the washers and the drying rooms. These items determine the amount of steam that must be provided. Adding enough to cover the loss by condensation, the gross amount determines the boiler horsepower. The possible output of power is now apparent. It remains to select electric heated machines and electric motor drives to the power capacity of the plant, and to add, if necessary, steam-heated machines and electric heated machines, or motors, in proportion, until the full equipment is provided. If there is a surplus of electricity, substitute a steam heated machine to use up some of the exhaust. If the exhaust supply is deficient, increase the power load by electric machines.

Possibilities of balancing the laundry power by right choosing of electric and steam heated units are only just beginning to be realized. The problem is one for a competent steam engineer in every case. The laundry owner who employs such an engineer at the commencement of his plans may expect to have an important advantage, not only in power cost, but in improved working conditions for his employes.

Notes on Using Kerosene

By James A. King

THE fuel question is growing vital. The question now is, how can I reduce the cost of running my engine? There are 2 general answers: one is, use cheaper fuel; the other is, use your fuel more economically.

Kerosene is the most attractive of all the future fuels. It is much cheaper than gasoline; it can be had at any country cross roads store; it is safer to store and handle.

But the great question to the average man is: how can I use it in my gasoline engine? Certain characteristics of kerosene as compared to gasoline must be understood in considering the answer to that question.

It is heavier than gasoline. For that reason the needle valve of the carburetor must be opened wider when using it than when using gasoline. This is necessary in order that the "suction" of the piston—which is constant—can draw out the proper quantity for a charge.

It does not vaporize nearly so readily as does gasoline. In order for an engine to properly explode its charge and get the most from this explosion, the fuel that is being used must be thoroughly vaporized and mixed with the air before ignition takes place.

Vaporization consists primarily in 2 distinct operations. First the suction draws the fuel from the fuel chamber into the air chamber of the carburetor and in doing this breaks the liquid fuel up into a fine mist-like spray. This spray should be delivered into the cylinder of the engine without its having a chance to condense into large drops. If it is allowed so to condense, the drops will collect on the walls of the passage instead of going on into the cylinder. One of the best possible preventions of this is a short passage between the carburetor and the inside of the cylinder. Second, this mist-like spray must be "melted" into a true gas or vapor. Most of this part of the process is done inside the cylinder by the heat that remains there from the previous explosions.

A throttling governed engine is best for using kerosene. Such an engine gives an explosion of some size at every cycle and so maintains a constant heat inside the cylinder. This gives, at all times, that heat necessary to vaporize the sprayed kerosene. Ordinarily a hit and miss governed engine will not work successfully on kerosene unless carrying at least from ⅓ to ½ of its maximum load capacity. And it should be carrying this load, or more, constantly. I have never yet seen such an engine work successfully on this fuel when it changed frequently and quickly back and forth from a heavy load to a light or no load. During the idle cycles, when the engine is taking no charges, the inside of the cylinder becomes cooled by the constant fanning in and out of cold air through the exhaust valve, 2 cylinders full of cold air each cycle. Then when it does unhook and take a charge the cylinder is so cooled that only a small part of the spray is vaporized during the compression stroke, probably so little of the first charge or so that the mixture is not rich enough to explode at all, at least only weakly.

Kerosene heats an engine more than does gasoline. This may be due to its burning more slowly and so putting more heat into the outer end of the cylinder where the heat interferes most with the working of the piston. It also has more of a tendency to carbonize the cylinder; this is especially true in cases of faulty carburetion (or rather in cases of carburetors which will successfully vaporize gasoline, but not kerosene). The use of a carburetor which sprays a small amount of water into the cylinder, with the charge of fuel, acts as an aid to the cooling system in caring for this heat. Also in some way, not fully known, this water spray greatly reduces the amount of carbon deposited.

To sum it all up briefly, the best results are had today in burning kerosene when one uses a thoroughly efficient carburetor in connection with a water spray and on a throttle-governed engine.—Gas Power.

Electrical Machinery and Appliances

For Generating, Transmitting and Using Current

Transmission Line Calculations

A Comparison of Size of Wire; Cost of Complete Line. By A. L. Temple

IT was recently necessary to determine the most economical voltage and type of pole line to transmit a small alternating-current load to a nearby factory. The load was estimated to be 400 kw. maximum at 80 per cent power factor, distance of transmission being 8000 ft. and a 6 per cent loss in the line considered permissible. The question came up as to whether it would be advisable to use 2200 or 11,000 v. for transmission, and as to whether or not the cost of line for the latter would justify its use, since the voltage must be stepped up at the power plant and down again at the factory.

To determine the proper size of wire, the following formula was used:

$$\text{Cir. mils} = (D \times W \times K) \div (P \times E^2)$$

In this formula, D is the distance in feet one way; W, the watts load to be transmitted; K, a constant, which for a 3-phase system is 1690; P, per cent loss in line; E, the voltage used. Substituting these values in the formula:

$$\text{Cir. mils} = 8000 \times 400{,}000 \times 1690 \div (6 \times 11{,}000^2) = 7450, \text{ or No. 11 wire.}$$

Although No. 11 wire is sufficiently large to transmit the power under the conditions named, it is known that for power purposes, where wire must be strung on poles, in order to keep the pole spacing at a reasonable distance, a size of wire smaller than than No. 6 does not possess sufficient mechanical strength to resist wind and sleet and make a safe construction. For construction at 11,000 v. and in order to protect against any danger due to a mechanical break of line or a stretching so that two wires of any phase will whip together in a windstorm, either No. 4 or No. 2 wire would in most cases be a better choice and represent better engineering. The following calculations show conditions which in addition to experience already named, help to determine the proper size of wire on the basis of initial cost and operation. In this case the calculations are given for Nos. 6, 4 and 2 wire.

The energy loss for the different sizes of wire is found from the following formula:

$$P = (D \times W \times K) \div (\text{c.m.} \times E^2)$$

For No. 6 wire, $P = 8000 \times 400{,}000 \times 1690 \div (26{,}250 \times 11{,}000^2) = 1.70$ per cent; for No. 4 wire, $P = 1.07$ per cent; for No. 2 wire, $P = 0.67$ per cent.

The voltage drop for the line $= (P \times E \times M) \div 100$ where P and E have the same values as before and M is a constant, which for a 3-phase circuit of 60 cycles, 80 per cent power factor, and No. 6 wire is 0.79; for No. 4 wire, 0.87; and for No. 2 wire, 1.00.

Then volts for No. 6 wire $= 1.70 \times 11{,}000 \times 0.79 \div 100 = 154$ v.; for No. 4 wire $= 102$ v.; for No. 2 wire $= 73.7$ v.

The values of K and M used in the formulas given are shown in the following tables for different circuits and power factors. The constant K for any power factor may be obtained by dividing 2160 (its value for direct current calculations) by the square of that power factor for single phase; twice the square of that power factor for 3-wire, 3-phase or 4-wire, 2-phase. It may be said here that the formula which uses the constant K, holds good for direct-current circuit calculations as well as alternating when the value of K is taken at 2160.

VALUES OF CONSTANT K

System	Power Factors				
	100	95	90	85	80
Single phase	2160	2400	2660	3000	3380
2-phase, 4-wire	1080	1200	1330	1500	1690
3-phase, 3-wire	1080	1200	1330	1500	1690

VALUES OF M FOR A CROSS-ARM PIN SPACING OF 18 IN.: FREQUENCY, 60 CYCLES

Size of Wire	Power Factors			
B & S	0.95	0.90	0.85	0.80
0000	1.53	1.64	1.67	1.66
000	1.41	1.49	1.50	1.47
00	1.32	1.36	1.35	1.31
0	1.24	1.26	1.24	1.19
2	1.12	1.10	1.06	1.00
4	1.05	1.00	.94	.87
6	1.00	.94	.87	.79
8	.97	.89	.82	.74
10	.94	.86	.79	.71

The value of M depends upon the size of wire, frequency and power factor. It is used to take account of the combined effect of resistance and reactance of a circuit. The values of M given by different authors vary slightly and it is advisable to use a larger value rather than a smaller one, as this will introduce a greater factor of safety in the calculations that may depend on voltage drop. The maximum voltage drop should be known at the time of making calculations for any circuit so as to permit the proper selection of wire size. The values as given in the table are correct within 2 per cent for all practical cases; that is, for cases where the line reactance is not excessively large or the line loss very high. They represent values at 10 per cent

line loss and close enough for practical use at all losses less than 10 per cent. For direct-current calculations, M should be taken as 1.0 in all cases. The formula and tables presented here will be found in the 8th edition of Kent's Handbook, page 1397.

The weight of No. 6 wire per 1000 ft. = 79 lb.; No. 4 = 126 lb.; No. 2 = 200 lb.

The cost of wire at 16 cents per pound is then: For No. 6 wire = $79 \times 8 \times 3 \times 0.16 = \$300$; for No. 4 wire = $126 \times 8 \times 3 \times 0.16 = \$485$; for No. 2 wire = $200 \times 8 \times 3 \times 0.16 = \$770$.

These calculations seem to show a copper cost decidedly in favor of No. 6 and No. 4 wire, however, a selection cannot be based on this data, as the loss in the line of delivered power is an important and ever present loss, and must be reduced as much as possible.

Power loss for No. 6 wire = $400 \times 0.0170 = 7.1$ kw.
Power loss for No. 4 wire = $400 \times 0.0107 = 4.3$ kw.
Power loss for No. 2 wire = $400 \times 0.0067 = 2.7$ kw.

The difference in power loss of No. 6 and No. 2 wire then is $7.1 - 2.7$ or 4.4 kw. For a 10-hr. working day and 300 days per year with current costing 3 cents, saving due to the larger size of wire, is $4.4 \times 10 \times 0.03 \times 300 = \$396$ a year; that is, the plant would be loaded to the extent of 4.4 kw. for which no revenue is received.

TOTAL COSTS FOR DIFFERENT SIZES OF WIRE

	No. 6	No. 4	No. 2
Wire cost	$300.00	$485.00	$770.00
Power loss at 3c. per kw.-hr.	639.00	387.00	243.00
	$939.00	$872.00	$1013.00

From these figures, for the 11,000-v. line construction, it is plain that No. 4 wire should be selected. We will now compare with the data already presented, that for 2200-v. construction so as to secure a check on the selection and to show how much variation in cost exists.

The size of wire required at 2200 v. is
cm. $= 8000 \times 400{,}000 \times 1690 \div 6 \times (2200)^2 = 186{,}000$, or No. 4/0.

No. 4/0 wire weighs 640 lb. per 1000 ft.

Then the cost of wire $= 640 \times 8 \times 3 \times 0.16 = \$2460$.

Energy loss $= 8000 \times 400{,}000 \times 1690 \div 211{,}600 \times (2200)^2 = 5.3$ per cent.

Power loss $= 400 \times 0.053 = 21.2$ kw.

Value of loss at 3 cents per kw.-hr. $= 21.1 \times 10 \times 3c. \times 300 = \$1899$ per year.

Total cost for No. 4/0 wire $= \$2460 + \$1899 = \$4359$.

Referring to the total cost charges against line copper for 11,000-v. construction, it is at once seen that 2200-v. operation is not nearly as favorable as 11,000 v. and that the higher voltage is the proper choice.

The cost of the complete line for 11,000-v. construction is as follows:

30-ft. wood poles @	$ 5.00
Wishbone cross-arms @	4.00
Insulators (3 @ 50c.)	1.50
Cost of complete pole	$10.50

With a pole spacing 100 ft., 80 poles are required, so that the pole equipment cost is $80 \times \$10.50 = \$840$ for the 11,000-v. construction, as against $540 for wood pins and cross-arms of the 2200-v. construction.

TOTAL COST OF LINE AS FOLLOWS

	11,000 v.	2200 v.
Cost of wire	$ 485.00	$2460.00
Cost of pole equipment	840.00	540.00
	$1325.00	$3000.00

These calculations show up the general law that the cost of copper for a line or the amount of copper required to transmit a certain amount of power at a certain loss varies inversely as the square of the voltage. Thus, if as calculated, the cost of copper for transmitting 400 kw. at a 6 per cent loss and 2200 v. is found to be $2460, then for 11,000 v. the cost could be expected to be $\$2460 : X = \overline{11{,}000}^2 : \overline{2200}^2$

$X = \$98$.

As already calculated, No. 11 wire at 11,000 v. is called for to transmit the required power at 6 per cent loss. This wire weighs 25 lb. per 1000 ft. Then, $25 \times 8 \times 3 \times 0.16 = \$96.00$. The cost of No. 11 wire as calculated, therefore, checks closely with the above general law. As already shown, however, No. 11 wire is not safe nor satisfactory for outdoor construction where long spans are required, and the problem brings in other conditions which are not named in the general law, and require careful consideration in order to select a proper size of wire, or one that will provide both mechanical strength and economical operation.

The efficiency of transformers has not been considered in these calculations for the reason that it would be very nearly the same for both transmission voltages and would not figure in the data on which the choice is based. The cost of the 11,000-v. transformers would, however, be about 6 per cent more than for 2200-v. transformers or the cost of 6 150-kv.a. transformers, 3 to each bank, one at the plant and the other at the factory, would be for the 2200-v. transmission about $3800; while for the 11,000-v. system, the cost would be about $4000. This increase in cost, however, is not enough to figure against the choice as made and the load at the expenditure called for and a 3 per cent rate should be a paying proposition, as in this case it proved to be, due to excess station capacity and certain peak load restrictions.

Electrifying the Anthracite Mines

SUBSTITUTION to a large extent of electricity for the direct use of both steam and compressed air in the anthracite mines of Pennsylvania is foreseen as a possibility in a paper read before the Engineers' Society of Northeastern Pennsylvania. The data for this "Historical Review of the use of Electricity in the Mining and Preparation of Anthracite Coal in the State of Pennsylvania" was gathered this summer by a committee of electrical engineers of which H. M. Warren of the Delaware, Lackawanna & Western Railroad Co., was chairman.

In a summary of apparatus in service at the conclusion of the paper, the grand total of electric generating capacity and power purchased for use at the mines is given as 79,811 kw., which is approximately equal to 105,400 hp. The horsepower produced by steam at the mines is given as 531,289 in the last Annual Report of

the Bureau of Mines of Pennsylvania. As 91,010 of this is used for electricity, this leaves 440,279 hp. produced by steam for direct use. Thus almost ¼ as many horsepower are transmitted electrically at the mines as are produced by steam for direct use.

The introduction of electricity in any great quantity into the mines is not more than 2 decades old. The first electrical installation was made in 1887 by the Pennsylvania Railroad Co. In 1889 the Thomson-Houston Co. installed a locomotive and a generating station in the Erie Colliery of the Hillside Coal & Iron Co. It is interesting to note that this locomotive was in service until 1911, or for a period of 22 yr. of continuous operation. The first electric pump installed was in 1890, and it has been in continuous operation ever since. From 1891 to the present year, plant after plant has been installed in the mines and a gradual evolution has taken place.

Today there are 169 miles of wooden pole lines above ground and 754 miles of trolley wire below ground in the anthracite mines. There are 951 electric locomotives using an estimated amount of over 60,000 hp. The other electrically operated equipment consumes 19,170 hp. for breakers and miscellaneous machinery, 23,280 hp. for electric hoists, 38,500 hp. for electrically driven pumps, 2920 hp. for coal cutting machines, 3650 for lighting and about 100 hp. for heating. There are now 5 breakers equipped with individual motor drives, and others are under course of construction.

Feeder Voltage Regulators

THEIR THEORY OF OPERATION; CONSTRUCTION; OPERATION; LOSSES

ENGINEERS operating plants supplying service to restricted territories where the length of transmission and distribution lines is comparatively short, are not confronted with the difficulty of being unable to maintain an approximately equal voltage on all circuits. This is a condition, however, which bothers the man responsible for the operation of the plant supplying energy to alternating-current circuits of great lengths and carrying unequal loads.

This condition exists in stations having 3-phase generators supplying single-phase circuits; and to overcome this difficulty voltage regulators are employed.

THEORY OF VOLTAGE REGULATORS

SINGLE-PHASE voltage (or feeder) regulators are autotransformers with their primary coils connected across the bus bars and their secondary coils in series with the feeder circuit. They are of 3 general types as follows: (a) A type in which the secondary coil has many leads brought out to points on a dial switch, so that the number of active turns on the secondary coil may be changed at will, permitting of the adjustment of the feeder voltage to any desired value.

(b) A type in which the primary and secondary coils are wound at right angles to each other on the inner face of a laminated iron ring, not unlike the stator of an induction motor. The magnetic flux, due to the primary coil, is made to pass in whole or in part through the secondary coil by turning a laminated core.

(c) Polyphase feeder regulators usually consist of several single-phase regulators, one for each phase. The advantage of this arrangement is that the voltage of each phase may be controlled separately. A combined polyphase feeder regulator is, however, sometimes used.

Figure 1 is a diagram of connections of the type of regulator outlined in (a). As may be seen, the primary coil is permanently connected across the bus bars. One feeder wire passes out directly from the generator and the other passes through few (or many) turns of the secondary coil and then to the line. The reversing switch, A_1, serves to connect the feeder, f, to one or the other terminal of the secondary coil, and the arm of the dial switch connects the line wire to any one of the taps which are brought out from the secondary coil. For one position of the reversing switch, the induced voltage in the secondary turns which are connected in series with the feeder circuit, is added to the generator voltage, thus raising the feeder voltage. For the other position of the reversing switch, the induced voltage in the secondary turns, which are in series with the feeder

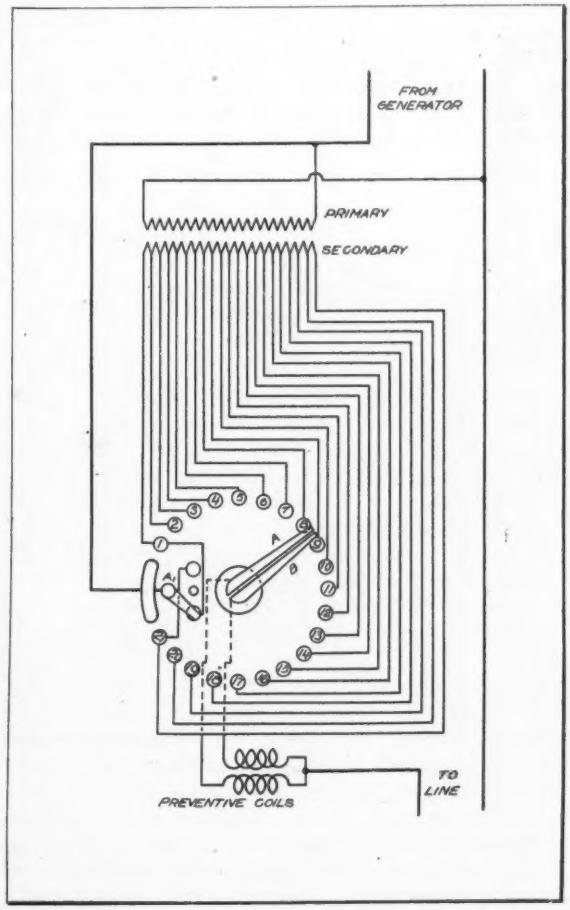


FIG. 1. INTERNAL CONNECTIONS OF TYPE (A) REGULATOR

circuit, is subtracted from the generator voltage, thus reducing the feeder voltage.

When the arm of the dial switch touches 2 adjacent contact points (and it must always be arranged to touch one point before it leaves the other) the intervening turn (or turns) of the secondary coil of the regulator is short-circuited. To overcome this difficulty, the arm is made double, as shown in Fig. 2; that is, of leaves

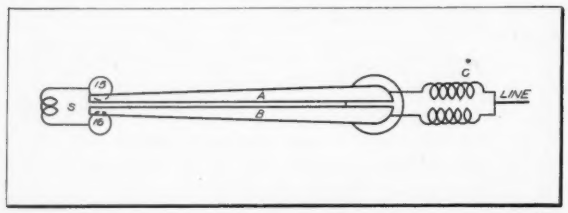


FIG. 2. DIAGRAM OF SPECIAL FORM OF DIAL SWITCH, TYPE (A) REGULATOR

A and B. These arms are shown connected to 2 contact points, say 15 and 16. C represents a special form of choke coil consisting of 2 windings on one iron core. These 2 windings are arranged so that equal currents flowing out from A and B circulate around the core in opposite directions so that the core is not magnetized and the windings of C have no choking action, except that when the 2 fingers, A and B, touch adjacent points of the dial switch, the turns of wire, S, on the regulator secondary tend to send a large current out on A, for

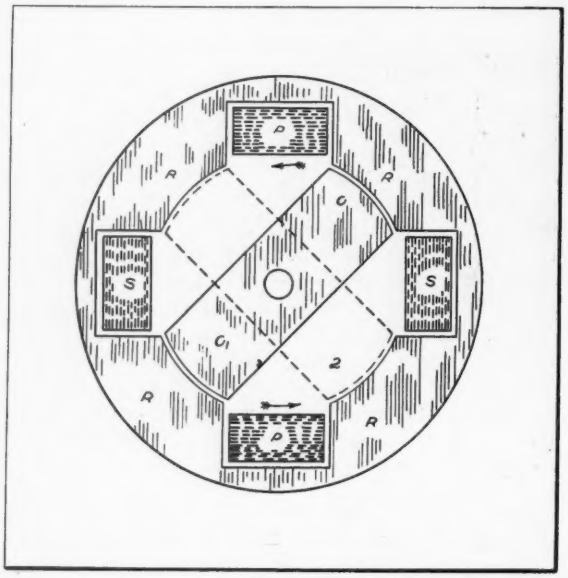


FIG. 3. DIAGRAM OF MAGNETIC VOLTAGE REGULATOR

example, and back on B. This current circulating around the cores of C in the same directions magnetizes the core, and the windings, in consequence, have a considerable choking action, the effect being to choke currents flowing oppositely in the fingers A and B, and to allow currents in the same direction to flow freely through them.

Under (b) is found a type of regulator sometimes called the magnetic voltage regulator. As shown in Fig. 3, a laminated iron ring, R R R R, has 4 large, deep slots on its inner face in which the primary coil P P and the secondary coil S S are placed. A laminated core, C C, mounted on a spindle is arranged to be turned into any desired position by means of a hand wheel or, as is now usually done, by a small electric motor. In the position indicated by full lines, the core carries the magnetic flux due to the primary coil in one direction through the secondary coil, and in the position indicated by the dotted lines, the core carries the magnetic flux due to the primary coil in the other direction through the secondary coil. When the core is moved slowly from position 1 to position 2 in the direction indicated by the arrows, the voltage induced by the secondary coil changes gradually from a full positive value to a full negative value in its relation to the primary volt-

FIG. 4. TYPICAL 3-PHASE REGULATOR WITH MOTOR CONTROL

age. That is, when the core is in position 1, the induced voltage in the secondary coil has its greatest value of, say, 100 v., which, if the coils are properly connected, is added to the bus bar voltage, E, giving a feeder voltage of E + 100. When the core is midway between 1 and 2, the induced voltage in the secondary coil is zero and the feeder voltage is then equal to the bus bar voltage, E. When the core is in position 2, the induced voltage in the secondary coil is again at maximum of, say, 100 v., but in such a direction as to oppose the bus bar voltage so that the feeder voltage is equal to E — 100 v.

A valuable feature of the magnetic type of regulator is that it produces a continuous variation of voltage, while the previous type described produces a step-by-step variation.

The third or induction type of regulator is so called from its similarity to the induction motor. Action of the induction regulator in simplest terms is as follows: A regular induction motor stator has its windings connected across the polyphase bus bars. The magnetic field thus produced rotates in synchronism with the generator or generators which are supplying current to the bus bars. Inside of this stator (or primary) is placed an induction motor armature which does not revolve, but it is mounted on a spindle so that it may be turned through an angle of 60 or 90 deg., either by means of a hand wheel or an electric motor. The rotating stator magnetism induces polyphase electromotive forces in the windings of this polyphase armature, which are in synchronism with the electromotive forces between the bus bars. The 2 (or more) windings of the polyphase armature are connected in series with the 2 (or more) feeder circuits (constituting of course one set of polyphase feeders) which are to be regulated. The electromotive forces in the stationary armature windings may be in phase with the bus bar electromotive forces, in which case the regulator raises the voltage by the greatest amount of which it is capable. By turning the stationary armature by means of the hand wheel (or motor) and worm gear, the phase difference between the bus-bar voltages and the voltages induced in the stationary armature windings may be gradually changed from coincidence of phase to opposition of phase, during which time the boosting effect of the regulator will gradually drop to zero, become negative, and reach its greatest negative value when opposition of phase is reached. Thus, if the electromotive force induced in each armature winding of the regulator is 100 v., and if the bus bar voltage (each phase) is 1000, then the voltage between the feeders can be varied from 900 to 1100 v., by means of the regulator.

Ratings of Regulators

The amount of power delivered to service mains at a slightly increased voltage produced by an auto-transformer is much greater than the power actually transformed from the primary to the secondary of the transformer. In fact, the power actually transformed is equal to the increase (or decrease) of voltage multiplied by the total current delivered, and the rating of the auto transformer (which determines its size) is based upon the power transformed.

For example, a voltage regulator is to be used for raising the voltage of 2000-v. bus bars to a maximum of 2100 v. and the maximum current to be handled is 100 amp. In this case, the transformer rating of the regulator is 100 amp. at 100 v. or 10 kw., whereas the total power to be delivered to the feeders is, at its maximum, 2100 v. $\times$ 100 amp. or 210 kw.

Since a voltage regulator transforms but a small fraction of the power delivered to the feeders which it controls, the losses of power in the regulator are small. Thus the 10-kw. regulator may have a total loss of 300 w., which is 3 per cent of the power transformed by the regulator and only 1/7 of 1 per cent of the total power delivered to the feeders.

By Electric Transmission

Some Troubles and Remedies Encountered in a Mill Plant. By Isaac N. Cory

USUALLY the chief of the power plant is a serious, silent individual; his stock in trade mostly consists of much thought, and clever scheming, relative to obtaining sure and economical results from both men and machinery, and keeping apparatus in operation at all times when required.

This in itself does not appear from the road to be a very serious problem; and the general public ofttimes gains the impression that the chief has indeed a so-called snap; "nothing to do till tomorrow," idea.

A young man who recently acquired the necessary license to act as assistant engineer in a large steam plant, was somewhat under that impression, although he was much pleased with the opportunity which had been given him, and vowed to himself that he would make good. The chief, of course, with his knowledge of human nature and ability to read character at a glance, was much pleased with his new assistant. He did not at the time express his opinion in spoken terms because he was a silent, thinking man, and one of the few (though not original) of his remarks, "A new broom sweeps clean," seemed to cover the subject, thus far.

The plant in question consisted of 2 cross compound steam engines, rated somewhat over the 2000 hp. mark; these were direct-connected to alternating-current generators, supplying current through transformers to electric motors throughout the mill; the fields of the generators were excited by a small exciter direct-connected to a turbine.

Many things may occur to disable such a generating plant. Suppose you were on watch, the telephone bell tinkles sweetly; you answer, and receive a message from the superintendent that not a wheel is turning throughout the mill; all is silent therein. You would probably glance immediately at the ampere and volt meters; these you find do not register any current passing through to the mill. The chief, who is also master mechanic, is in a distant part of a new addition to the mill. Such was the situation in which our young assistant was placed. Now, where would you begin to look for trouble? Think it over and try to decide for yourself before you read further. Time is precious; operatives throughout the mill are standing idle; the loss of time means a big loss of capital invested in the production of goods.

You would test connections and circuits; yes, so did the assistant, and no results. When he had at last exhausted all the resources his busy brain could muster, the chief suddenly arrived, glanced at the switchboard, then walked over to the steam turbine exciter and placed a revolution counter on the shaft center, and in 15 sec. remarked: "Two hundred revolutions under speed," and closed the steam valve, thus shutting off steam to the turbine, then removing the wire mesh basket, or strainer, which was a part of the steam end casting of

the turbine, he emptied out on the floor a half pint of pipe cement, various pieces of gasket and one healthy three-quarter nut which had collected in this strainer, and which was placed there for this very purpose; after replacing the strainer, the turbine was started and immediately came up to speed.

It is proper to state that a new exciter was soon installed of the motor generator type, taking current direct from the machine, after that had been brought up to speed and fields were properly charged by the turbine exciter. This sounds simple and it is simple, as many other things which occur in the daily routine; another little incident which no doubt would be of interest to many, occurred shortly after.

As summer approached, the hot days began to make things look serious about the generator fields. They would heat up more than it was comfortable to have them heat, and at times would give the engineer some anxious hours, inhaling the odor of hot insulation; here again was a problem to solve, and it appeared to be a serious one if something was not done soon.

The chief decided to place a heavy galvanized iron pipe about 4 in. in diameter around the generator, with an opening at each field; so Tom, the tinsmith, was given an all-night job, making the pipe.

A fan direct-connected to a motor was placed just outside a window, in the lower floor of the mill, and the fan with the required galvanized iron piping was connected to the piping around the fields of the generator. After all work had been completed the fan was placed in operation, exhausting its air from the outdoor atmosphere around the fields of the generator. The men in the engine room were much pleased with this appliance and the smell of smoking insulation was no more. But, sorry to relate, one morning soon after, the brushes on this generator began to spark in a most unaccountable manner, much dust was found to be flying about, and further investigation disclosed the fact that a fireman was dumping ashes right under the intake of that fan which was supplying cool air to the generator fields. The fireman was in ignorance of the trouble he was causing, and the chief made a few remarks that are not taught at school and immediately built the intake pipe of the fan right up toward paradise about 15 ft.; this worked with good success, and cured all evils.

Many interesting experiences might be written; one such was that of the engineer, who had trouble keeping the speed of a large compound engine anywhere near constant. The generators were connected in parallel, and this engine would race, so that out would come the circuit breaker. All kinds of theories were advanced as to the cause thereof, and there were some good engineers present at this caucus, too. The belt on the governor pulley was reasonably tight, and rods and cams evidently working free, of proper length and adjustment; dashpots worked free and silently. No one could seem to fathom the trouble; so, with much distress and evident signs of discouragement, the chief was called. He listened to his audience with patience and made no comment on the situation, but soon appeared again with a pint of engine oil and poured it into the governor oil dashpot, remarking as he did so, he thought for the amount of oil it would do the most good here. There after the speed became constant, and once more the chief had imparted a bit of information acquired only by his long, patient and constant study of details, which perhaps some of the young chaps naturally think really too insignificant to bother about, and which are the principal points to be looked at many times.

Some Costs of Power Plant Equipment

A Subject Neglected by Engineers and Engineering Schools: Costs of Reconstruction and Additions; Fair Idea Gained by Basing Costs on Unit Ratings

IT IS a well known fact that the average operating engineer has a tendency to become too technical and loses all sight of the commercial side of his profession and, as a consequence, becomes one-sided and narrow.

This state of affairs exists not only in the so-called self educated man but also in the college bred engineer, and it is a situation with which our technical schools are at the present time face to face. A man may be graduated having all the qualifications of a first class electrical or mechanical engineer, but the commercial training which his alma mater has given him does not enable him to know the price of a monkey wrench or a 1-hp. electric motor.

It must be admitted that all lines of industry are brought more or less into contact with the commercial side of life and if an engineer does not recognize this and refuses to have anything to do with the cost of the various machinery in his charge he will surely remain far behind his more progressive and alert fe" ien.

It is seldom that an engineer can give h loyer or superior officer the approximate cost of iler, an economizer, a new generating unit, switchboards and switching equipment or the cost of extending or constructing a building.

While no drawings accompany this article to convey any details to the reader, yet from the figures given below he will be able to obtain a fair idea of the cost of the average prime mover, condenser, condensing machinery, switchboards and electrical apparatus, economizer, and building construction. By noting the ratings of the various items, he will at least be able to approximate the present cost of equipment per unit rating. The costs quoted are the actual figures for the various items and were obtained during the reconstruction of a 14,000-kw. power plant which involved the addition of new equipment and replacing of old and the entire rebuilding of the engine room. This last item consisted of removing an old 15-ton hand operated crane, removing an old wooden roof and the tearing down of old brick walls. These were then replaced by new walls, crane columns and girders, a new 25-ton power crane and a steel-concrete roof.

Various Costs of Apparatus and Work

For convenience and clearness, the various items with their costs will be tabulated as follows:

Removing old wooden roof	$ 300.00
Removing old 15-ton crane and steel work	350.00
Removing old walls	500.00
Building footings for crane and balcony columns	1400.00
Installing crane columns and girders	5400.00
Buildings new walls	9400.00
Plaster and painting of one wall of engine room	1300.00
Building new roof	8575.00
Installing one 25-ton power crane	6000.00
Extension to boiler room for economizer and fan	2500.00
Foundation for 5000-kw. turbine, condenser and hot-well pump	1760.00

By noting the above, it will be seen that only those items of a purely building construction nature have been mentioned. Below are given the costs of the machinery, piping and electrical apparatus:

1 5000-kw. turbine and generator	$54,000.00
Surface condenser, circulating pump and necessary piping for above	35,000.00
Steam, water and oil connections for 5000-kw. turbine	3,500.00

The total cost of this 5000-kw. generating set, including its foundation but no electrical wiring, amounts to $94,260, or approximately $18.85 per kw.

Tearing out old hand operated switchboard and replacing it by a modern benchboard and remote controlled switches, new transformer room, bus structures, engineers' panels and station lighting required the expenditure of $53,520, or $38.10 per kw. of rated station capacity.

Next in importance in the reconstruction work was the installation of an economizer and fan in connection with 4 575-hp. water-tube, stoker fired boilers. Two thousand five hundred dollars was paid for the extension to the boiler room for the economizer, $13,000 for the economizer, fan and flue connections, while the piping and connections amounted to a cost of $3000. The combined cost is, as seen, $18,500, or about $8 per hp. rating of the boilers.

In addition to the above-mentioned extra transformers were installed and wiring done; but as these items are chargeable to the transmission system, no mention has been made of them.

Phasing-Out 3-Phase Transformers

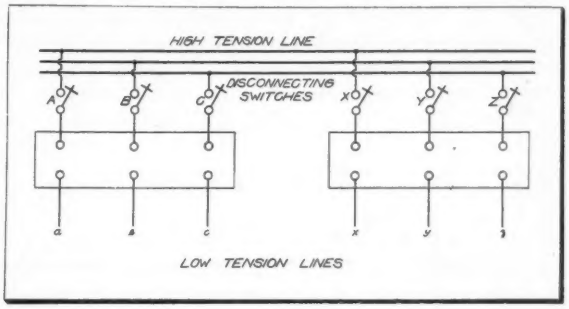
In order to operate satisfactorily 2 3-phase transformers in parallel, they should have like ratios, impedances, polarities, and phase rotations.

When connecting 2 transformers of different manufacture, it cannot be assumed that the similar leads of the 2 transformers will be the ones that should be joined. Before making any electrical tests, it should be made certain, in order to have proper phase relation of the secondary voltages, that the transformers are properly connected. Next, each transformer when connected to the high-voltage line should give equal voltages between the low-voltage terminals, and the values should be equal in both transformers, that is, ab = bc = ca and xy = yz = zx, also ab = xy, bc = yz, and ca = zx.

Before the low-voltage leads are connected together, the phase rotation of each set of these leads should be checked so that, when a, b and c are connected in that order to the same terminals as x, y and z, the same direction of rotation will be produced on whatever device is used, whether it be a so-called phase-rotation indicator or a 3-phase motor. (Phase rotation can be reversed by interchanging any 2 of the external leads on one side of a transformer.)

When the voltage and phase rotation are correct, polarity must be determined before all of the low-voltage leads are joined together in the final connection. To make a positive test for polarity, first connect 2 leads together which are supposed to go together, for instance, a and x. Now, if zero voltage is indicated across b and y and across c and z, b may be connected to y and c to z, and the phasing-out is complete.

If, however, the polarity of x, y, z is opposite to that of a, b, c, even though the phase rotation is the same, twice the line voltage will be read across b-y and c-z. The phase connections on one side of one transformer



CONNECTIONS OF 3-PHASE TRANSFORMER BEFORE PHASING-OUT

must then be reversed. That means, if a delta, the delta must be opened at each corner and each coil reversed; if a Y, the neutral must be broken and each coil have its opposite end connected to the neutral point. Only one side of either transformer, however, should be changed in the case of different polarities. This case also assumes that a and x, b and y, c and z are the proper terminals to be finally joined.

It may happen that x, y and z do not correspond in order with a, b and c, but should be a, b and c to y, z and x or a, b and c to z, x and y.

In such a case, where the polarity is the same in 2 transformers, the voltage readings b-y and c-z will be 1.73 times line voltage when a and x are joined. The proper relation of x, y and z to a, b, and c may be determined by joining y and z in turn to a and measuring the voltages b to z, and c to x, or b to x, and c to y respectively.

The foregoing, briefly stated means, that if the 2 leads which are joined together *are the correct ones to be connected,* then the voltage readings taken between the others (corresponding according to phase rotation) indicate, if equal to zero, the proper terminals to be joined; while, if of twice normal voltage, indicate opposite polarity. If any other indication is given, *the leads are not the correct ones to be joined;* and other connec-

tions should be tried until either zero or twice normal voltage is read between the leads of the second pair and the leads of the third pair, when the leads of the first pair are connected together. When the reading twice-normal-voltage is obtained, a reversal of the polarity of one transformer should be the only change necessary to prepare the machines for parallel operation.

In measuring the voltages, enough capacity is required to measure twice the normal line voltage. Potential transformers, if used, would most likely be rated at the line voltage and should, therefore, be connected 2-in-series when taking the readings during the process of phasing-out. Voltmeters or lamps used on the secondary side of the potential transformer would have to cover the range of voltage of those windings. It should be borne in mind, however, that when only one voltmeter is employed and that one being connected across the secondary of only one of the potential transformers where there are 2 in series, its readings will have to be multiplied by twice the ratio of the transformer to give the voltage of the high side.

In case the voltage of the low-tension sides of the main transformers is sufficiently low to enable the use of lamps without potential transformers for testing out, enough lamps should be connected in series to burn properly on twice the low-tension voltage.

The following table gives the possible combinations of 2 3-phase transformers or banks; those marked with "√" will operate in parallel, the ones marked with "×" will not.

Transformer or Bank "A"

Transformer or Bank "B"		△△	△Y	Y△	YY
	△△	√	×	×	√
	△Y	×	√	√	×
	Y△	×	√	√	×
	YY	√	×	×	√

—General Electric Review.

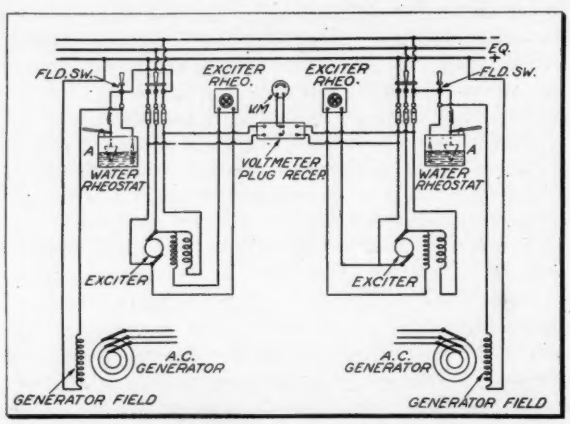
Exciter Connections

SWITCHBOARD AND GENERATOR CONNECTIONS; FIELD DISCHARGE RESISTANCE. BY R. A. CULTRA

DUE to the fact that when a separate exciter is employed for each alternating-current generator, the instruments and switches of these exciters are mounted on the same panel as those of the main generator, the average engineer considers this part of the equipment of small consequence. The above arrangement is one which, in the early days of alternating-current machinery, was found in every plant and may still be seen in those stations which were built in the 90's, or in the smaller sized plants of to-day. Modern central station practice, however, demands the use of an exciter the capacity of which is great enough to furnish the proper excitation for all of the alternating-current machines in the plant, with perhaps an extra one to be used for emergency or alternate operation. The use of one large exciter results not only in higher efficiency but also in better voltage regulation.

When one exciter is used for the entire plant, a separate switchboard panel is provided for it, from which are carried bus bars to the various generator panels and connected to the alternator field windings through a field switch. The accompanying diagram illustrates the wiring connections for 2 alternating-current generators, and 2 exciters only one of which is to be used at a time. As may readily be seen, these exciters are compound-wound and so connected through an ordinary equalizer that either one may be cut in or out without service interruption.

Fields of alternators are excited by throwing in the field switch and the degree of excitation may be varied by means of the field rheostat, and when the alternator is shut down, all that is necessary to discontinue the excitation is the opening of the field switch. In this part of the operation lies more or less danger due to the inductance of the alternator field windings. At the instant of opening the field switch, the current flowing



WIRING DIAGRAM FOR 2 ALTERNATORS AND 2 EXCITERS

through the field coils is decreased in value and as a consequence, the magnetic flux surrounding these coils is also quickly decreased. As the conductors which constitute this field coil winding are within this decreasing magnetic field, a very high electromotive force is induced in them, which becomes a source of danger not only to the operator but also to windings themselves, tending to puncture their insulation.

This trouble may be overcome by employing some form of discharge resistance, and the one illustrated, while simple and easy to construct in the plant, is effective. As shown, a liquid rheostat using a solution of ammonium chloride (sal-ammoniac) and 2 iron plates, one of which was V shaped, was used.

When an alternator is shut down all of the resistance of its field rheostat is cut in, after which, with the V shaped plate submerged, the field switch is opened and then the plate gradually withdrawn. This arrangement will care for any high voltage induced in the field windings.

In new installations, the field switch is usually provided with a carbon or other high resistance to take the inductive current at the instant of opening.

Jeremiah Judson

ON THE CUSSEDNESSS OF MONKEYING

IT was Saturday night. It was also "meetin' night." Usually some of the boys brought their wimmen folks down town to assist in paying the grocery bill, and buy a few things for the kids, a new feather for the last year's bonnet, to make it look like a this year's model run over by a dray. After a half hour at the movies, the ladies take the car for home, leaving the old man to go to meeting an hour late.

But on this particular night there seemed to be a tacit understanding of some sort, for about 7:30, 5 of the boys met at the corner by the Emporium (millinery shop, not a saloon), almost at the same time, so they went up to the rooms and after making the air look like a No. 3 smoke chart, they fell to telling how they had saved the country since the last meeting.

One little incident brought on another, till finally Gust Schwartzenheimer, told of an amusing little affair that happened at his plant a day or so before, when 2 of the assistants, each unknown to the other, had "fixed" a certain little apparatus, and each was telling about how bad shape it was in and how well it ran after he got through fixing it. It wasn't definitely settled just who had the first chance to try his skill; but at any rate, each declared that when he tackled it, he could not see how it could possibly run in the condition it was in. And as Gust said, "there was such a thing as having too many engineers on the job."

"Well, sir," began Jeremiah Judson, as he drew a match along his trouser leg, and lit another length of Pittsburgh delight, "that reminds me of the time,"—puff—puff—puff—"a number of years"—puff—"ago, and he threw the match at the cuspidor with unerring aim, "when I ran across a little affair where there really were too many engineers on the job. That is, each said he was an engineer but there was no direct evidence, either visible, audible, or otherwise, that any of them knew a handhold crab from a governor ball."

Jerry puffed a while in silence, while he went over his mental files for the necessary data. Everyone knew enough to keep still—all but Bloom. He started to say something about his new secondhand automobile that he was so unfortunate as to own. But Cadwell gave him a jab in the ribs with his elbow and, at the same time said in a stage whisper, "Shut up, you—" but he didn't say the rest, for Judson laughed and started in as follows:

It was when I was a young fellow (that is, younger than I am now, which is not much) when I was testing engineer for the Whiz Crank Engine Co. They made nothing but small engines; that is, comparatively small, and practically all of them verticals.

"They catered to small plants for small factories and laundries, and made a special feature of direct-connected units from 5 to 50 kw. as auxiliary independent lighting systems. These little units found a ready sale, and the regulation had to be good, as you will know. For testing, we had about all that the heart could desire in the way of shafting, generators of several sizes, pulleys, water rheostats, banks of lights, etc. The switchboard hit me one day and made a leyden jar out of me, so I designed a new board and submitted it to the superintendent.

"He looked at it and asked if I thought it was all right, and of course I could't go back on my own design. so he ordered the switches, copper, etc. When it came. I made a new board out of the old one, so that several outfits could be tested at once, either singly or in parallel, or on any of the water barrels or banks of lights, to suit the needs.

"Well, one day we had to test an engine—10 by 10 in., if I remember right;—yes, that was the size. We were not equipped to load that size engine fully with our outfits, so we had a prony brake as an extra attachment for such emergencies.

We belted the engine to the lineshaft with the light pulley on one side, and from the shaft we drove a few generators used for small belted engines. The combined electrical load was about half of the i.hp. of the engine, so we put on the prony brake, rigged up the scales and water supply, on the heavy governor pulley, and cut loose. This was some rig, belted to 4 generators (2 on water barrels, and 2 on banks of lights) besides running the factory (after a few trials to get regulation) and then the prony brake on the other side. throwing out water and smoke.

"Well, my story does not deal directly with this end of the affair, but I mention it to show that we put the engines through a gruelling test before leaving the shop. so that there wouldn't be any question of regulation and endurance. The foreman and the superintendent came in when I called them, and went over the test, as was usual, so that there would be at least 2 "say so's" on the accuracy of it.

Everything was as nice as could be desired. It so happened that this engine was bought by a concern to run part of a plant located not over a mile from our works; so when the engine was pronounced O.K., the purchaser sent up one of their "low-down" platform wagons (like they use to haul stone on), and we rolled the engine out of the testing room right onto the wagon.

"In fact, when that engine was delivered to the purchaser that afternoon, it was still so hot that you couldn't touch the cylinder. All they had to do was put on the steam pipes, and let her go. I didn't even take off the oil cups when we put the rig on the wagon. as they were in a hurry to get it going and take off a heat in the foundry.

"About 4 o'clock next day the office boy said they wanted to see me in the office. Well, what do you think? The engine was on the bum already, so the 'phone said. Would I go out; Sure. So I jumped on my wheel and in 5 min. was at the scene of hostilities.

"She takes steam only every other revolution," was the reply to my inquiry, and in order to make the statement stronger, he said that he was the engineer. Well. he didn't look the part, but I took his word for it.

"And did he have it running? Oh, sure he did. Well, let's see her perform. So he sticks a crow bar in the wheel and hoists her over, and without regard for the heads he let her rip. There was about 100 ft. of

steam pipe from the boiler to this engine, and the exhaust pipe looked like a display fountain, or a geyser in Yellowstone Park. But the heads held, and the exhibition of the 'power of mind over motor' revealed the fact that she was doing considerable coughing at one end but none at the other, to speak of, although when she left me the previous afternoon, about 5, she had an exhaust as smooth and sharp as a rifle.

"'What did you do with her?' I asked; although I knew for a certainty what caused the mischief.

"'You see that big nut on top of the steam chest, with the rod bobbing around in it?' he asked, referring to the balanced valve stem on the steam valve, which projected about 5 in. above the top of the chest at extreme travel, and which was guarded by a big nut or gland, with an extension sleeve to protect the stem.

"Yes, I saw it.

"'Well, that thing struck on the top of the door when we moved it in, so we took it off and then the stem struck, so we unscrewed the eccentric rod and turned the wheel so the top of the stem was flush with the top of the chest; then she went in.'

"'Didn't he screw it back again?' 'No,' and then I was informed that *it didn't make any difference.* This is the first time I ever knew that there was no definite place for a valve on a valve stem.

"Well, I had everything trammed, either 3 in., 6 in., 9 in., or 12 in., as the case required, and in about a minute the engine was all right again. So giving him a parting warning, I went back to the shop and reported to the office.

"Two days after that, the signal of distress came in by 'phone again, and this time there was another man on the job who said he was the 'only engineer.' What was the trouble? Nothing, only the flywheels were not round and there was a pound in the shoes, and as soon as he took them up, she got hot. Well, she certainly did get hot, and those lumen bronze shoes were a sight. However, I got them fixed up and new oil grooves in them and cleaned out the oil holes.

"Then to investigate why the wheels had suddenly become elliptical. It was all clear; someone had loosened the main bearing nuts—probably the other 'only engineer.' So at every stroke, the piston lifted the shaft and slapped it down again. This noise was traced to the shoes, so they were taken up till they smoked—and still the wheels ran out of round.

"This engineer, by the way, ran the washing machine where they washed the foundry scrap, to be sure that there was no iron going out into the dump. But, after giving him some parting advice, I went back to the shop, not having seen or heard of No. 1 engineer.

"The evil genius seemed to pursue that job. Next day—I think it was—they sent in again for a wet nurse, so out I went, and found still a third engineer on the job who was ignorant of the fact that there had been 2 before him.

"No, he was *the* engineer—the whole thing; all others are imitation. None genuine without this signature, etc.

"Well, what was the trouble? It could be seen at a glance. The entire inside of that vertical frame had been given as nice a coat of babbit spread on evenly, as one would want to see. The crankpin box was melted out.

"Being a marine end rod, with turned bolts in reamed holes, it was an easy matter to take the box off. Going to the phone, I told the shop to put the babbit on, and when I got there a few minutes later, with the box, it was an easy matter to melt out the remainder of the babbit on the little forge, and still hot, we slipped it on the mandrel and poured in the lining.

"We hastened the cooling process as much as possible, drilled the oilholes, and cut the grooves. After adding a thin shim, we started back to the job with the box, fully expecting to find engineer No. 4 on the job, but No. 3 evidently held over till his successor was properly installed, although No. 4 really did land on the job some time later.

"In a few minutes, we were running, and in half an hour the foundry was preparing to take off a heat. I stayed a little to see if the hoodoo came around so as to nail it. But everything was all right, so I went back to the shop.

"The Superintendent collared me, and wanted to know what was the trouble and I said, 'Too many engineers.' Well, that was a poser. But I explained it all, about as I have given it to you fellows, and he turned to the 'phone and got the new owners of the engine on the wire. Say, he said some few things that startled me and I also learned something.

"He asked who their engineer was and was told that they didn't have any, only a fireman. Well, who ran the engines? Anybody. So he said that unless they put in an engineer,—only one,—that he would go out there and take the engine away from them, as they were not any too well supplied with money. Well, sir, they *did* get an engineer, and from that day they began to make money and if I were to tell you the name of the concern, you would be surprised."

At this moment, President Bert Ellis came in with another bunch from the movies, and Biff went the gavel:

"The meeting will please come to order," and we ranged up along the wall.

Climbing to the Top

By Frank Farrington

IF a man has no desire or inclination to reach the top, there is no need for him to know anything about how to climb there. He will never do any climbing himself.

Much has been said about the advantage of being contented. Contentment is a good thing; but it is likely to become too much of a good thing if a man makes it his hobby. Contentment may keep a man down by making him satisfied with his present condition in life. You never find a perfectly contented and an ambitious man in the same pair of shoes.

If a man is to climb to the top, the first thing he needs is ambition. He must want to get to the top, and he must not stop with wanting; he must make up his mind that he WILL get there, that he is entitled to a top place and that he can fill it properly. The man who has determination can do just about anything he sets out to do.

A man may have all kinds of ability and yet fail to get the position he wants for lack of ambition and de-

termination, for lack of a real desire to get it and a real determination that he will get it. Ability without something behind it will not get a man to the top.

When a man lacks confidence in himself, he can not convince others of his ability. A lack of self-confidence is always contagious and a man may better be conspicuous for his arrogance and conceit than inconspicuous because of his modesty. The man with abundance of self-assurance has a valuable quality, but when self-assurance reaches the bluffing point it has gone too far. The first rule in the book for the man at the top is to deliver the goods. He cannot make deliveries by means of a bluff. A man may secure a higher position by bluffing, but there the value of the bluff ends. Nowadays, the man at the top must be a man of action, a man who does things even though he does them wrong at times. It is easier to excuse occasional mistakes than to excuse a chronic lack of initiative. The employer wants men who are not afraid, when confronted by an unusual and unexpected situation, to decide for themselves what should be done and do it instead of excusing themselves on the plea that their instructions did not cover that point.

Employes are unwise to take matters into their own hands needlessly, and there must be judgment behind initiative if it is to be really valuable. But self-confidence and the knowledge of when to act and when to hold back mean much in getting a man to the top when he is once on his way.

Naturally, some employers will condemn a man every time for a failure when he has thought it wise to use his own judgment, but there are others who recognize the ability behind the willingness to assume a little independent responsibility.

He who is rising will find plenty of places open and waiting for him; and he who is going down will find plenty of holes waiting. The man who doesn't care is either on the toboggan or getting on. He will soon be shooting toward the bottom, his place to be filled by somebody on the way up.

A young man who possessed the qualities of a natural salesman started in as traveler for a small jobbing house. He was not long in getting to be high man on the payroll, and when he reached that point he saw that the house could not afford to raise his salary any higher and began to slow down. He took to spending Sundays in the towns where the sports of the traveling fraternity liked to "Sunday." He was soon thinking more about how he could have a good time than about how he could sell goods. Booze and backsliding go together and it was not long before the house would occasionally have to send a man out to bring in the star salesman from some town where he found intoxication too attractive.

An acquaintance who knew the real selling ability of the young man saw that it was not an inherent love of sporting life that ailed him. He merely lacked a goal ahead, an inspiration to further exertion in his work. His surplus energy was finding the wrong kind of an outlet. This acquaintance took the young man out of the house he was with and got him started at the foot of the list of traveling men with a really big concern, where there was an object to work for, something to climb toward, and the old enthusiasm for work returned and there was no time for sporting life. Today he is again high man, but with abundant necessity for work to hold his position at the top.

When a man finds his ability is in reality beyond the needs of his position, when he finds himself at the top with his present employers, it is time for him to change and get into a lower position in some line where the top towers higher. Not every man has a friend to drag him out of deep water and set him on firm ground; but any man can prepare to overcome the small or the large obstacles in his way, and any man can fit himself for a better position.

The National Cash Register Company bids all its employes "Think!" It impresses this command upon their minds whenever possible. Most men, especially young men, think entirely too little. They work hard at what they are told to do; but they think little about the reasons for what they are doing, how they can do it better and how they can learn to do something of higher value.

To the command, "Think!", I would add another almost as important, "Study!" If a man is to get very near the top he must study, and think about what he studies. Nothing will do a man more good or develop in him important qualities faster than studying the methods used by others farther advanced than himself.

You cannot drift up-stream. The force of gravity is against a man sliding up toward the top. It takes constant work to climb up and it requires intelligent work instead of a mere endeavor to lift one's self by one's bootstraps. We must get hold of something outside of ourselves to help us. If we do not keep our eyes open for projecting opportunities to grasp them when they present themselves, we will be likely to find them grasped by somebody else first. It is preparation that enables a man to climb when he sees something he wants to reach. The man who takes it easy will not have the mental or the physical strength to climb when the way is opened to him.

When you see a man you think has fallen into an easy job, you see a man who has climbed there, or else the job is not what you think it is. You may not have seen that man climbing and seen the strenuous endeavors he made to get within reach of that excellent position. Just because you did not see him pass you does not indicate that he did not go by.

Climbing to the top is not a joy-ride. It is not always easy or agreeable and it is seldom speedy; but it is certainly decidedly worth while, and it gets you where you want to go.

IN A TEST on a 115-hp. Locomobile unit in the plant of the International Cork Co., Brooklyn, N. Y., running at 100 per cent rating, with a steam pressure of 210 lb., superheat of 171 deg., and a receiver pressure of 30 lb., a steam consumption of 13.7 lb. per b.hp.-hr. was secured, and of 22.9 lb. per kw.-hr., the coal consumption being 1.36 lb. per b.hp.-hr., and 2.27 lb. per kw.-hr. With a load 120 per cent of rating, steam pressure of 212 deg., superheat at 205 deg., and a receiver pressure of 40 lb., the steam per brake horsepower-hour was 13.4 lb., and per kilowatt-hour 21.3 lb. The coal consumption per brake horsepower-hour was 1.31 lb., and per kilowatt-hour 2.12 lb. The heat value of the coal in each test was 14,070 B.t.u.

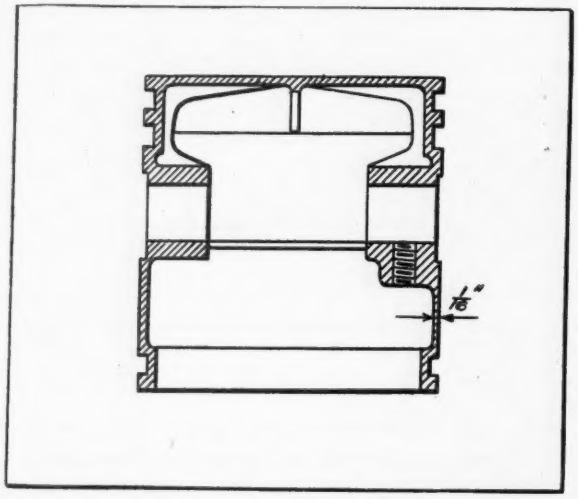
Foreign Development in the Power Plant Field

MANUFACTURE OF BRICKS FROM SLAG; TREATMENT OF BOILER PLATES; EXTRA LIGHT PISTONS. BY J. H. BLAKEY

PRODUCTION of slag in blast furnaces is so abundant that only its use for the manufacture of an article having as widespread use as the brick, could create a demand for it sufficient to exhaust the supply. A recent number of Stahl und Eisen describes 2 processes of manufacture which are giving good results.

Slags may be acid or basic; accordingly, different methods of treatment have to be followed. In the case of acid slags, the slag is granulated and mixed with lime and water. They are then molded and cooked in a superheated steam; in a few hours, bricks of excellent quality are obtained.

The basic slags are cooled in air and finely ground, then, without any other addition than water, are molded and treated with a current of carbonic acid.



LIGHT-WEIGHT PISTON FOR HIGH-SPEED ENGINES

Sometimes to these finely ground slags is added a granulated slag, in the proportion of 50 per cent. This is done to facilitate the penetration of the carbonic acid and to reduce the time of setting. They are then baked in an oven; the time required to harden them being from 40 to 50 hr.

The bricks containing 50 per cent of granulated slag have, on coming out of the oven, a resistance to compression of about 1½ tons per sq. in., and this resistance increases on exposure to the air. At the end of about a year this resistance reaches 350 kg. per sq. cen. Although their faces are very smooth they adhere well to mortar.

The cost of manufacturing a thousand of these slag bricks amounts in Germany to about 12 francs, without taking into account the metal caught in the magnetic separators which are placed at the discharge from the grinders.

BOILER PLATE TREATMENT

IN A RECENT number of Stahl und Eisen, M. Klein gives the following rules for the working of boiler plates, in order to avoid making them brittle by partial tempering:—

1. During the whole of the operation, the plate should be maintained at a red heat, or, if the deformations are such as to permit it, it should be worked cold.
2. When a plate is to be worked only in places, the area surrounding the part worked should also be brought to a red heat, so as to prevent deformation and the setting up of internal strain after cooling.
3. All pieces which have been worked hot should be annealed before being put in place.

M. Klein says that it is to the neglect of these rules, much more than to the bad quality of the plate, that cracks and fissures are to be attributed.

EXTRA LIGHT PISTONS FOR HIGH SPEED ENGINES

ADVANTAGES of decreasing the weight of all reciprocating parts in high speed engines are so obvious as to require no argument. Experiments made by M. Contet in France recently have shown that an engine in which the ordinary cast-iron piston was replaced by one of aluminum gave an increase of power of about 15 per cent. An automobile engine, which at its maximum speed of 1600 r.p.m. delivered 20 hp., was found to attain a speed of 1900 r.p.m. when the aluminum piston was used. A chart showing power developed at different speeds shows the advantage of the lighter piston all along the line; at 1600 r.p.m. the aluminum piston gave 22 i.hp., and at 1900 r.p.m., 23.25 hp., the cast-iron piston dropping at this speed to 19.6 hp.

In a recent number of Omnia, M. Lacoin states that although the cast-iron piston may be superseded by one of aluminum, still there are a great many things to be said in favor of the former. Especially in the matter of friction and lasting qualities, aluminum does not seem to be the equal of cast iron for this purpose. For this reason great efforts have been made to manufacture a cast-iron piston of extreme lightness. M. Binet has, by a special method of molding, been able to produce a piston which has a shell thickness of only about 1/16 in., and that without interior machining. A test of these pistons gave a rupturing strength of 257 lb. per sq. in., which compares favorably with the strength of pistons made in the ordinary way, and is quite sufficient for the great majority of purposes.

AT PERNAMBUCO, Brazil, a new electric railway and lighting system, begun in 1912 is about 25 per cent completed. There will be some 62 miles of track, a general power station and 2 sub-stations. The power plant equipment is American and English, including 4 1000-hp. B. & W. marine type boilers, 4 1000-kw. turbo-generator sets and a 400-kw. direct-connected engine set. Current will be 3-phase, 50-cycle, delivered at 220 v.

Operating a Small Ice Machine

CONDITIONS OF RUNNING AND DETAILED COSTS. BY J. C. HAWKINS

IN A recent issue, W. S. asks for more details on the operation of our small ice machine. During the past 3 yr., the machine has been operated as suggested by him; that is, usually just long enough each day to freeze the amount of ice required, but the brine pump is operated continuously. Usually the compressor, which is rated at 4 tons of refrigeration or practically 2 tons of ice per 24 hr., runs long enough to bring the temperature of the brine down to about 8 deg. F., or a little below; then it is shut down. In winter, when only a small amount of ice is pulled each day, the compressor is run a few hours every other day; but during the summer months, the machine runs every day as long as needed.

Ice is pulled in the morning, and the machine is operated at night (except during July and August) on account of the electrical load conditions. At the time of starting up, the brine will usually be at a temperature of 24 to 30 deg. Sometimes the temperature of the brine goes above 32 deg. for a short time, in which case the ice in the cans melts around the edges. It was thought at first that the re-expansion of the water thus melted would, in freezing, expand, and possibly burst the cans, or start the seams leaking; but up to the present time the cans are not even bulged. Letting the temperature go above 32 deg. is not to be recommended, however, as there is a possibility of trouble from this source.

The compressor is driven by a 7.5-hp. motor, which is connected to the compressor through a silent chain drive, and uses from 25 to 30 amp., direct current, at 220 volts, the amperes used depending on the head pressure.

The condenser is of the double pipe type using city water which, after passing through the condenser, passes through the water jacket of the compressor. In cold weather, the head pressure is sometimes as low as 90 lb., as the cooling water at that time is cold; while in summer, the pressure runs as high as 165 lb. Back pressure is carried as high as possible without frosting back on the compressor cylinder, as more ammonia can be sent through the coils in a given time than with lower pressure, and ranges from 32 lb. with the brine at 30 deg. to 15 to 18 lb. with the brine at 6 or 8 deg.

In order to figure the cost of the ice, the cost of the plant and other data are necessary. The complete plant installed, cost $2800. Current for the motor costs 1 cent per kw.-hr. in winter when the heating system is using the exhaust steam, and 2¼ cents in summer. The ice plant is operated in connection with the electrical and heating plant, and requires on the average about 2 hr. in each 24 of the engineer's time. Ice is pulled by a laborer as needed, except when filling the storage room, and takes but little time, which is charged to another department. The compressor is of the enclosed crank case type and requires about 10 gal. of oil per year.

From the above we get the following charges: The cost of power in winter is $25 \times 220 \times 1 \div 1000 = 5.5$ cents per hour of operation. In summer the cost is $30 \times 220 \times 2\frac{1}{4} \div 1000 = 14.8$ cents per hour of operation. The cost of labor is estimated at about $10 a month in winter, and $25 in summer, when the machine is operated continuously, although usually it is operated only part of the day in summer. Interest and depreciation on the investment of $2800, allowing 5 per cent for interest and 10 per cent for depreciation, as the machine is apparently short-lived, is $35 a month; oil, waste, calcium, ammonia, etc., will average about $1 a month.

Table No. 1, given herewith, shows the hours the machine was in operation during each of the 5 months, the amount of ice pulled, the cost of power, which was at the rate of 5.5 cents an hour in March and April, and 14.8 cents an hour during the other months. The labor cost varies with the length of time the plant is operated each month; the minutes that the compressor is operated to freeze 100 lb. of ice in 24 hr. is found by multiplying the hours the compressor operated by 60 and dividing by the hundred-weight of ice pulled during the month.

TABLE NO. 1. COST OF OPERATING 4-TON ICE PLANT

1913	March	April	May	June	July
Hours operated...	158¼	244½	342¾	412	390
Lb. ice pulled....	39,800	53,000	59,800	81,600	80,600
Power cost $.....	8.70	13.44	50.82	60.97	57.72
Labor (est.) $....	10.00	12.50	15.00	15.00	14.00
Supplies $.....	1.00	1.00	1.00	1.00	1.00
Total months cost $.....	54.70	61.94	101.82	101.97	107.72
Cost of ice per cwt., cents.....	28	23.3	34	25	26.7
Minutes Compressor operated per 100 lb.....	24	27.7	34.4	30	29

REPORT FOR MONTH OF MAY

Date	Pounds pulled	Hours run	Ammonia Pressure High	Ammonia Pressure Low	Brine Temp. Start	Brine Temp. Stop
1	1600	7	115	23	22	10
2	1600	10.5	110	24	23	12
3	1200	7	110	20	30	14
4	1200	7	110	18	30	14
5	1200	7.5	110	22	30	15
6	1000	6.5	110	20	30	12
7	none	0	.....	.....	.....	.....
8	1200	7.5	115	20	30	12
9	3000	15.5	115	22	30	16
10	3200	15	115	22	30	18
11	2600	15	120	20	32	14
12	3000	15.5	120	20	32	16
13	100	15.5	120	15	28	10
14	none	.....	.....	.....	.....	.....
15	3000	6.5	.....	.....	.....	8
16	3000	15.5	125	20	31	.....
17	2800	15	125	20	32	18
18	3200	8	127	20	22	18
19	3000	24	135	28	32	14
20	4000	15.5	135	28	30	17
21	none	24	135	23	31	7
22	3800	17	140	23	29	20
23	4000	16	145	23	30	20
24	4000	21	145	25	30	20
25	4000	24	155	27	28	18
26	3800	24	150	25	.....	16
27	3600	17.5	155	27	32	18
28	none	24	150	22	26	6
29	4000	24	150	25	.....	10
30	1400	24	150	23	.....	6
31	4000	24	145	23	.....	10

It will be seen that during the month of May the machine did not do so well as during the other months. The reason for this was thought to be that the brine in the tank had gotten low and water was added to bring it up to the proper level. This addition of water weakened the brine, and more calcium was added; but there was not enough calcium on hand to bring the specific gravity up to the proper point, consequently the freezing point of the brine was so high that the temperature

could not be carried as low as during the other months.

The table also shows that in June and July it required a longer time to freeze 100 lb. of ice per 24 hr. than earlier in the season. This, I think, was because the water used in the cans, which comes direct from the city service main, was at a higher temperature than during the colder months.

The monthly report for May is as shown:

The ammonia pressures are the averages during the time in operation.

Increase in pressure during the latter part of the month is due to the cooling water warming up during the warm weather. This plant is only a small part of the mechanical equipment of the plant, and possibly has not received the attention that it should; but during the 3 yr. that it has been in operation it has saved enough in reducing the cost of ice to pay the greater part of the first cost of the plant.

Ammonia Compressor Efficiency

EFFECT OF CONDENSER PRESSURE AND COMPRESSOR CLEARANCE ON CAPACITY AND EFFICIENCY. BY W. D. SPOONER

WITH reference to the answer given by J. S. Bell to L. E. M., page 986, Oct. 1 issue, the statement that lowering the condenser pressure cuts down the efficiency of the compressor, with a consequent loss in refrigerating capacity, needs discussion. Suppose that the compressor operates at a back pressure of 15 lb. gage. This is equivalent to a temperature of 0 deg. F. in the expansion coils.

With the condenser pressure at 190 lb. gage, the temperature of the liquid ammonia at the exhaustion valve will be about 98 deg. F., and latent heat 487 B.t.u. It is evident that the ammonia must be cooled to the temperature of zero when it expands. To bring about the cooling of the liquid, part of it must evaporate for that purpose only, and of the 572 B.t.u. of latent heat per pound of ammonia at 15 lb. gage, 572 — 98 = 474 only are available for effective cooling work. The loss is 17.2 per cent, very nearly.

If the condenser pressure is lowered to 170 lb. gage, the temperature of the liquid will be 91 deg. F. Then 572 — 91 = 481 B.t.u. are available for effective cooling work, and the loss is 16 per cent. The net gain is 1.2 per cent. A machine making 200 tons of ice with the condenser pressure at 190 gage, would make 202.5 tons when the condenser pressure is lowered to 170 lb. In making the calculations, it is assumed that the specific heat of liquid ammonia is 1, which is not quite correct, but near enough for the purpose of illustration. From these simple calculations, it is plain that there is a gain and not a loss in refrigerating capacity and efficiency when the condenser pressure is lowered.

We know that with a given amount of clearance, the greater the compression ratio, the greater is the loss in actual displacement.

At 190 lb. condenser pressure, the compressor pressures are 190 + 14.7 = 204.7 lb. absolute, and 15 + 14.7 = 29.7 lb. absolute. The ratio is then 204.7 ÷ 29.7 = 7, very nearly. At 170 lb. condenser we have 170 + 14.7 = 184.7 lb. absolute pressure, and the ratio is 184.7 ÷ 29.7 = 6.

It is well known that all gases increase in volume as the absolute pressure upon them is reduced, and in almost direct proportion to the reduction of pressure. Suppose that the compressor in this case has 1/32 in. clearance. With a compression ratio of 7, the gas remaining in the clearance space will have to expand to 7 × 1/32 in. before the pressure in the cylinder is low enough to permit the suction valves to open. When the compression ratio is 6, the gas will expand to only 6 × 1/32 = 3/16 in.; therefore, there is a gain, and not a loss in volumetric efficiency of the compressor.

With regard to the clearance space in a wet compression machine as a liberally proportioned quantity, it is just as essential to keep the clearance as small as possible in a wet compressor as in a dry compressor. The clearance in an ammonia compressor should not exceed 1/32 in.

It is with the end in view of keeping the clearance as small as possible, that some makers of wet compression machines have the heads and pistons made spherical and of the same radius. The valve disks conform to this radius, and when the valves are seated, these disks are flush with the heads. With this construction, no pockets are formed by the valve ports, and should an excess of liquid ammonia get into the cylinder, it will not, on this account, have to re-expand before the suction valve can open.

In double acting ammonia compressors the clearance is fixed, and cannot be altered, except possibly by increasing or reducing the thickness of the gaskets under the cylinder heads. In single-acting machines, the clearance can be adjusted to any quantity; but it should be carefully watched by occasionally setting the crank on the top centers and screwing the piston rod out until the piston touches the head, and then screwing the rod in just a little. In this way the clearance can be adjusted to a fine degree.

What a reasonable discharge temperature is does not seem to be clear in the minds of some operating men. Whether, with a wet or dry compression machine in use, the suction pressure is regulated to the most suitable for the particular plant. Then, if the suction gas is handled right, the discharge temperature will take care of itself.

With reference to the clearance in dry compression machines being too small to take care of a dose of liquid, this statement might give the idea that the clearance space in a wet compression machine is intended for that purpose. To those who are thoroughly acquainted with wet compression practice, it is clear that any quantity of liquid ammonia passing into the compressor in excess of that required to take up the heat of compression is a great loss. A very small quantity of liquid ammonia in excess of the quantity required will expand into a large volume of gas, which fills the cylinder to a large extent, and greatly reduces the capacity on the suction stroke.

The term "wet" does not exactly express the condition of the discharge gas. The object is to have the discharge gas in a saturated condition, that is, in a condition in which temperature and pressure correspond with each other.

GAS POWER APPARATUS

Producers, Engines and Industrial Applications

Wood Refuse Suction Gas Producer

By J. C. Van Langendonck

IN these days of keen competition, the economical use of refuse is one of the most pressing problems in the lumber as well as all other industries, and any invention to this end is sure of the most careful attention; as a result, this new producer has been developed.

The plant illustrated herewith by photograph and print is rated at 50 hp. and is located in a sawmill on the English Continent, where, as is usual in sawmill work, the load carried by the engine varies considerably; but even under these conditions it is found that the producer readily responds to any demands which may be placed upon it.

Operation of Producer

Operating principles of this producer are much the same as those of the standard type of suction gas plants; viz., the generator is filled with fuel which is ignited,

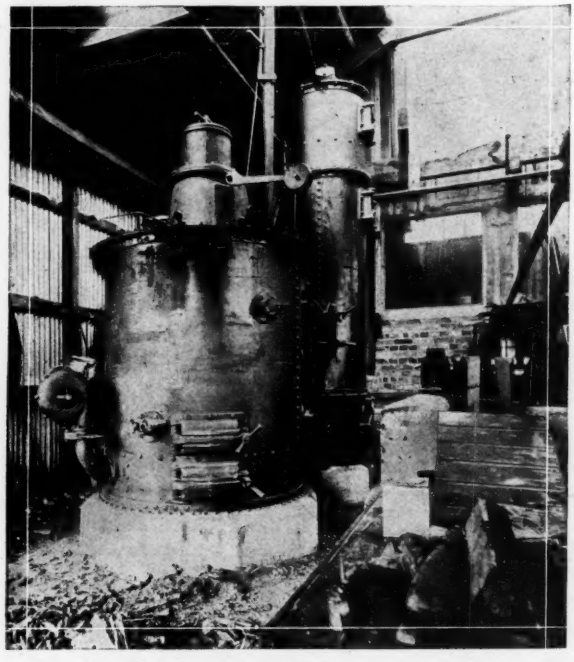


FIG. 1. WOOD REFUSE BURNING SUCTION GAS PRODUCER

and on the suction stroke of the engine a slight vacuum is created throughout the producer, so that air is drawn through the grates and into the generator. As this air passes through the hot body of fuel, such chemical reactions take place that a combustible gas is produced. Unlike the anthracite producer, no vaporizer is required as the necessary steam for enriching the gas and at the same time keeping down the temperature of the generator is derived from the moisture contained in the fuel itself.

The generated gas next passes from the upper part of the generator into a dust collector, thence to the base

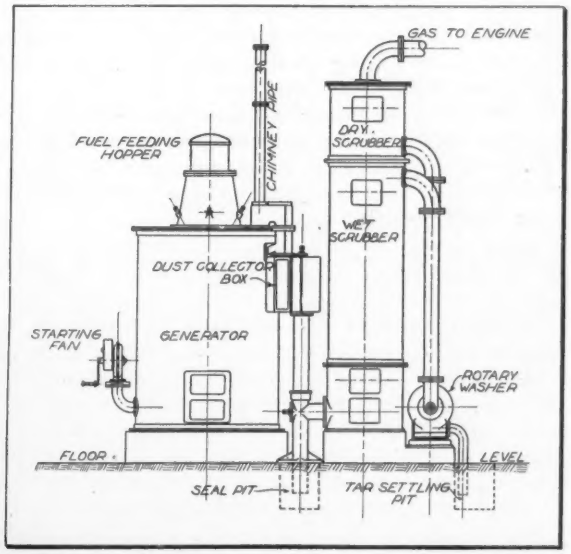


FIG. 2. GENERAL OUTLINE; WOOD BURNING PRODUCER

of the coke scrubber, which is a vessel filled with coke and kept damp by a spray of water, and then enters a rotary washer, where it is freed from all tarry matters and impurities. Leaving the washer, the gas is drawn through a sawdust scrubber, where it is dried before passing to the engine.

In order to avoid the admission of any excess air while replenishing the fire, a balanced plate valve is fitted to the hopper on the top of the generator, which is so designed that there is no possibility of any light fuel becoming blocked in the hopper and so being prevented from passing to the generator.

It has been found, in almost all plants working upon wood refuse, that there is a tendency for the pipes between the generator and the scrubber to become choked with tarry matters and sawdust carried over from the generator, and in this new plant particular attention has been paid to this point with the result that all

trouble of this nature has been entirely eliminated. For this purpose, a dust collector of special design has been placed between the generator and scrubber, and so arranged that the gases in passing through it are brought into intimate contact with jets of water, which serve the double purpose of cooling and cleaning the gas and keeping the passages free from all deposit. Any sawdust which may be drawn over with the gas is washed down the gas pipe into the seal pit, whence it can readily be removed without in any way interfering with the proper operation of the plant.

To avoid any undue suction on the engine, the sawdust scrubber is made of ample size, while the coke scrubber is provided with a cast-iron base and fitted with an improved type of sprayer. Connection for the chimney is made directly to the top of the generator, thus avoiding any bends or pockets for the accumulation of tarry deposits and at the same time no troublesome cock or valve is employed, the chimney being closed by means of an airtight cover operated by a spindle and lever. Poke holes are arranged in suitable positions around the generator body and at various points in the gas connections.

Starting the producer is comparatively simple and the attention required during operation is a little more than that demanded by an anthracite plant. Owing to the special design of the generator, a uniform draft is created throughout the entire body of fuel, and successful gasification is maintained without constant poking down of the fuel. As there is practically no clinker formed in the generator, it will be seen that renewals of firebrick lining and grates will be necessary only after considerably longer periods of running than would be possible with ordinary anthracite plants.

Economy of Producer

At full load the fuel consumption is from 2½ to 3½ lb. per brake horsepower hour, according to the quantity of moisture present. The total water consumption, including coke scrubber, centrifugal washer, and sprayers in gas connections, is from 3 to 4 gal. per brake horsepower-hour. From 2 to 5 hp. is necessary to drive the centrifugal washer, and arrangements can be made for doing this by means of a counter shaft driven by the engine proper, thus avoiding the employment of an independent unit.

Effect of Compression on a Small Gas Engine

Degree of Compression Varied by Special Cylinder Head; Economy of Engine Increases up to Certain Compression Ratio, Then Decreases

TESTS conducted at the University of Cincinnati bring out some interesting results on the effect of varying the compression in a small gas engine. In this series of tests, an effort was made to determine and to explain the effect of increasing the compression, upon the economy of a gas engine.

To explain any possible variation in the economy of an engine, it was deemed necessary to know the distribution of the heat value of the fuel. This was distributed in 6 ways:

1. As power at the brake;
2. As friction of the engine parts;
3. As incomplete combustion;
4. As heat to the cooling water;
5. As sensible heat in the exhaust gases;
6. As heat lost through radiation and leakage.

The first was determined by a Prony brake, the second calculated from the brake and the indicated horsepower, and the fourth was found by weighing the water to the jacket during the test and measuring its temperature rise. While a calorimeter was used to obtain the heat values of the exhaust gases, it was not possible to measure directly the heat lost through incomplete combustion, leakage and radiation.

The engine used in these tests was a vertical, single-cylinder, 3-hp., 4-cycle gas engine of 4¾ in. bore and 8⅛ in. stroke and originally had an automatic inlet valve which, in order to maintain conditions constant during the admission stroke, was replaced by a mechanically operated valve. Governing was hit-and-miss, the exhaust valve being held open and the gas valve remaining closed during a miss; while the inlet valve operated constantly.

In order to vary the degree of compression, it was necessary to redesign the cylinder head, providing for its vertical adjustment by telescoping it in the cylinder and placing spacer rings under the shoulder. By adopting this method, any desired clearance was obtained by inserting a ring of proper thickness under the cylinder head. It was decided to use compression ratios ranging from 2.5 to 1 up to 8.5 to 1 and the thickness of the rings was made accordingly, 7 being used and giving 8 advancing compression ratios.

Other minor alterations to the ignition system and valve mechanism were necessary on account of the cylinder head adjustments.

The auxiliary instruments and apparatus used were, a Prony brake, Crosby indicator, a Tobey gas meter, a Schaeffer and Budenberg speed counter, platform scale, together with the necessary thermometers for the measurement of jacket water temperatures.

Calorimetric test of the gas was made and the higher heating value found varied from 1100 to 1110 B.t.u. per cu. ft., corresponding to a lower heating value of from 996 to 1006 B.t.u. per cubic foot and as a fair average for the heat value of the gas was 1000 B.t.u. per cu. ft.

The following table is a sample report showing the data taken in each of the tests:

Compression Ratio 4.2

(1)	Duration of test	60	min.
(2)	Average r.p.m.	437.6	
(3)	Average b.hp.	4.365	
(4)	Average i.hp.	5.93	
(5)	Mechanical efficiency	73.3	per cent
(6)	Gas consumed in test	60.8	cu. ft.
(7)	Gas consumed per b.hp. hr.	13.95	cu. ft.
(8)	Gas consumed per i.hp. hr.	10.23	cu. ft.
(9)	Thermal efficiency at brake	18.25	per cent
(10)	Weight of jacket water used	258.6	lb.
(11)	Average temperature rise of jacket water	84.6	deg.

(12)	B.t.u. absorbed by jacket water	21,820.
(13)	B.t.u. absorbed by jacket water per b.hp. hr.	5,000.
(14)	Weight of exhaust calorimeter water used	580. lb.
(15)	Average temperature rise of exhaust calorimeter water.	28.87 deg.
(16)	B.t.u. absorbed by exhaust calorimeter	16,720.
(17)	B.t.u. absorbed by exhaust calorimeter per b.hp. hr.	3,830.
(18)	Thermal equivalent of the i.hp. necessary to develop the b.hp.	3,470.
(19)	Approx. B.t.u. lost by radiation and incomplete combustion	1,750.
(20)	Percentage of total heat to i.hp.	24.9
(21)	Percentage of total heat to jacket water	35.8
(22)	Percentage of total heat to exhaust	27.4
(23)	Percentage of total heat to radiation and incomplete combustion	12.52

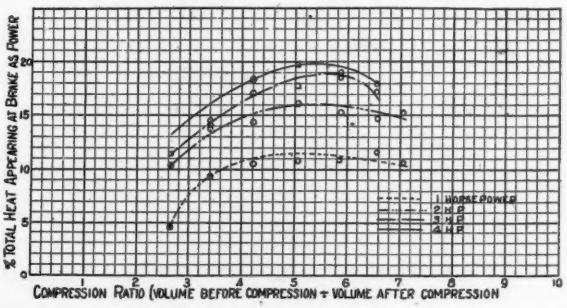

% TOTAL HEAT APPEARING AT BRAKE AS POWER
COMPRESSION RATIO (VOLUME BEFORE COMPRESSION ÷ VOLUME AFTER COMPRESSION
1 HORSE POWER
2 H.P.
3 H.P.
4 H.P.

FIG. 1. VARIATION OF EFFICIENCY WITH COMPRESSION RATIO

Compression Ratio	Maximum Horsepower
2.675	3.71
3.38	4.13
4.20	4.21
5.07	4.71
5.86	5.32
6.52	5.18

From inspection of the curves in Figs. 1 and 2, for gas consumption and thermal efficiency, it may be noted that a large gain in economy is obtained up to a compression ratio of 5 and 6, above which at all horsepowers, the economy tends to fall off. This decrease in economy at the higher compression ratios is due to the loss through mechanical friction steadily becoming greater, the loss to the jacket, the exhaust losses and those to incomplete combustion, radiation and leakage all reaching a minimum and then increasing.

Decrease and subsequent increase of the jacket loss may be due to the fact that at the low compression ratios strong afterburning took place, giving high temperatures during a large part of the stroke, and, therefore, large loss to the jacket. At the high compressions, the temperatures were very high and the jacket loss would therefore tend to increase. Safety of packing and valves would also demand more cooling. No direct relation seemed to exist between the final temperature of the jacket water and the heat absorbed.

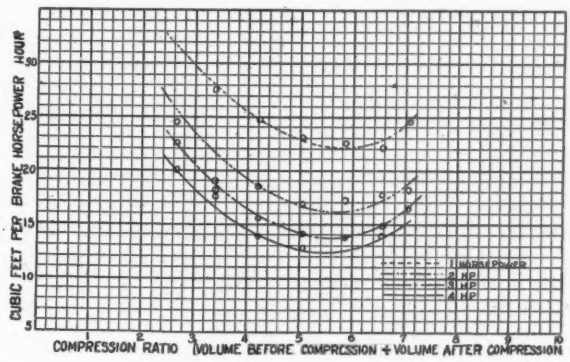

CUBIC FEET PER BRAKE HORSEPOWER HOUR
COMPRESSION RATIO (VOLUME BEFORE COMPRESSION ÷ VOLUME AFTER COMPRESSION
1 HORSE POWER
2 H.P.
3 H.P.
4 H.P.

FIG. 2. GAS CONSUMPTION PER BRAKE HORSEPOWER-HOUR AT VARIOUS COMPRESSION RATIOS

The variation of the loss of sensible heat is more difficult to explain, while the high loss at the low compressions is due to afterburning of the charge.

These tests were made by E. G. Roehm and W. W. Tangemann, and reported in The Gas Engine.

The Limiting Powers of Marine Diesel Engines

THERE is at present, and always has been, a great deal of discussion in regard to the maximum power which will be obtained from internal-combustion engines. At one time the large gas engine is under discussion and the next time the Diesel engine is the topic. It is evident that there must be a limit somewhere, but what that limit is would be extremely difficult to prophesy, in view of the steadily increasing sizes of engines now being built. It seems that the limit has just about been reached in the large gas engine at about 7000 hp.; not for constructional reasons, but because the transportation facilities now offered will not readily accommodate any larger castings than those now in service. With the Diesel engine, however, it is different. Until quite recently it was anticipated that the largest size in the 4-stroke cycle type would be a 6-cylinder engine of about 1500 hp., but this has already been exceeded, with excellent prospects of even larger engines in the near future.

A few comparisons between the 2-stroke and the 4-stroke cycle engines now in use will be of interest. The largest 4-stroke cycle marine Diesel engine in use is a 6-cylinder motor developing about 1600 hp., or a little over 280 hp. per cylinder. The cylinder dimensions are: bore, 29.1 in.; stroke, 43.4 in. The largest marine 2-stroke cycle engine in use is a 6-cylinder engine of 1800 hp. at 100 r.p.m., or 300 hp. per cylinder. The dimensions of this engine are: bore, 23.6 in.; stroke,

43.4 in. It would appear that the limit had just about been reached with the 4-stroke type; but it may be that some builder will bring out an engine with slightly larger cylinder sizes, giving 400 b.hp. per cylinder, which, with an 8-cylinder engine, would give a total horsepower of 3200. It may be stated here that no 8-cylinder engine has as yet been built, but it may be brought out in the near future.

A larger 2-stroke cycle engine than this has already been built, however, this being a 6-cylinder engine of 4000 hp. built by Sulzer Bros. The horsepower per cylinder is 670 and the dimensions are: bore, 29.5 in.; stroke, 39.37 in.; speed, 130 r.p.m. The high power is helped somewhat by the relatively high speed of revolution, which might be objectionable in a marine motor. Engines of 2000 hp. have, however, been built turning as high as 127 r.p.m. Bearing these facts in mind and also that a single-acting 2-stroke cylinder has been built for experimental purposes from which 1500 to 1800 hp. was obtained without serious difficulties, the conclusion would seem to be that engines developing 1000 to 1200 hp. per cylinder will not be at all uncommon in the future. The 4-stroke cycle engine will not be built in sizes over 400, or possibly 500 hp. per cylinder. Engines above 1000 hp. per cylinder will probably be of the double-acting, 2-stroke type.

An analysis of a large number of engines, using the actual developed horsepower as a basis and at a normal speed, shows that the piston displacement of the 2-stroke engines is almost exactly 7 cu. ft. per min. per hp., while 11.6 cu. ft. is the average for the 4-stroke engines, which is about 65 per cent larger than the 2-stroke, with corresponding dimensions and speed.

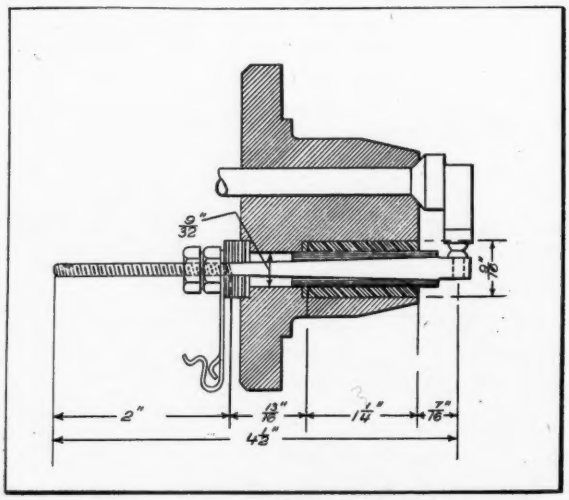
This analysis also showed that the piston displacement of the port scavenging type of engine was no greater than that of the valve scavenging type for the horsepower developed. It appears that a higher mean effective pressure is allowable in the port scavenging engine than in those using valves, but in the larger engines a bigger proportion of the stroke will have to be devoted to the ports, and this will no doubt be a disadvantage.—The Gas Engine.

Standard Electrode for Gas Engines

WE submit herewith an illustration of a standard electrode as recommended for adoption at the June Convention of the National Gas Engine Association.

This electrode is made up of a standard taper pin which has been threaded on one end and drilled for igniter point material on the other. This taper pin is driven into a 9/16-in. O. D. steel sleeve through a tube of pure mica. This mica being of an even thickness allows the taper pin to be driven into the sleeve accurately so as to have the igniter point always in the same position with relation to the sleeve. A manufacturer will bore his igniter plug to receive the 9/16-in. sleeve at the cylinder end and will extend the hole through to the outside 9/32-in. diameter, counter boring to receive the mica washer on the outside of the plug. The electrode is locked in place by 2 hexagon nuts and lock washers. The insulating material on the outside of igniter plug casting is composed of mica washers built up of sufficient thickness to insulate properly. Where the steel sleeve shoulders against the igniter casting, a copper-bound asbestos gasket is supplied to avoid any danger of blowing by, due to compression or expansion from the inside of cylinder. The igniter points can be made of any material suitable for this purpose. The illustration shows clearly the method of installing the electrode in an igniter.

Engine manufacturers and dealers will readily see the advantages of adopting some standard on stationary electrodes in make and break igniters. The dealer, isolated from his factory, and with possibly a dozen makes of engines on his floor, having trouble with igniter insulation would have to write his factory for a new one; as the matter now stands he is unable to rob one engine to repair another of different make. These electrodes are as interchangeable as a spark plug, and if adopted by



N. G. E. A. STANDARD ELECTRODE

different engine builders, would be a great boon to manufacturers, dealers and users alike. An electrode can be replaced in an igniter plug in the field in a few minutes; they are cheaper to make than the average stationary electrode and are much more durable. With the present tendency toward magneto equipment, better igniter insulation is necessary. This electrode will avoid short circuits which are common to most other stationary electrodes.

For the convenience of the trade, these have now been put on the market and can be purchased in either large or small quantities. They are made up of a standard length of 4½ in. from center of igniter point to the outside of the threaded portion. Builders of short igniter bodies can clip off the threaded portion where it extends beyond the nut, as the thread is run back fully 2 in. on the taper stem, thus avoiding the necessity of carrying in stock different lengths of electrodes to fit different makes and sizes of engines.

ROBT. E. MULLANE, former treasurer of The D. T. Williams Valve Co., of Cincinnati, O., has been elected president, succeeding D. T. Williams, who resigned Sept. 21, 1914.

LETTERS DIRECT FROM THE PLANT

Cash Paid For Ideas Accepted. Sketches Desirable.
We Make The Drawings

Operating Taylor Stokers

In my Oct. 1 issue of Practical Engineer I read with interest an article by H. J. in regard to operating Taylor stokers. In our plant we have 94 500-hp. water-tube boilers, including 2 types of forced draft stokers, one of which is the Taylor.

Our stokers are of the 6-retort type with movable extension grates. Although the best methods of firing would vary with the kind of coal fired and the conditions of service, there are a few general principles which apply in nearly all cases.

After a period of 2 to 3 hr., the fires should be in a fit condition to clean. If properly cared for, there will be no large masses of clinkers and cleaning will be accomplished in a very short time and with but little trouble. When ready to clean, close the extension damper, raise the extension grates (if movable) and lower dump grates; the fire should quickly clear of the ashes accumulated.

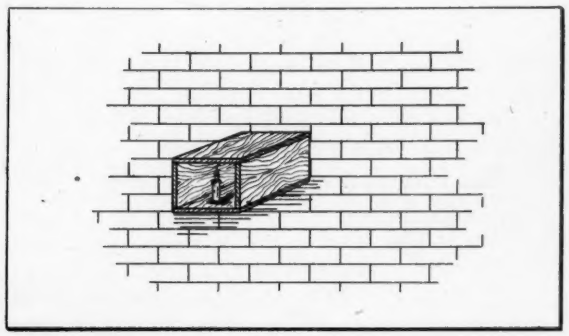


FIG. 1. METHOD OF TESTING BOILER SETTING FOR LEAKS

During the 2 or 3 hr. run, the fuel bed in front of the extension plates has become quite heavy and should now be nicely leveled off by working the extension plates and applying the long stroke to the lower plungers for a period of a few minutes. The draft conditions mentioned by H. J. appear to me to be uneconomical. Each boiler should be equipped with automatic wind-box and stack dampers. Such dampers would maintain a constant draft in the firebox, and the smoke troubles and unbearable gases spoken of in the boiler room would be eliminated. Also, the fan engine and stoker should be speeded up and slack down as nearly together as possible. Too much regulation is objectionable; try to get as steady a running condition as possible so that it is not necessary to throw the stoker clutch constantly in and out.

Constant starting and stopping of stoker engine and fan engine, throwing in and out of clutches, and large variation of draft condition inside of boiler setting all tend to hinder economy and efficiency. A steady feed of coal and air, with automatic draft regulation and cleaning of fires at short intervals, give satisfactory results to the man in charge. L. T. Mart.

Air Leaks in Boiler Settings

Some time ago I was called upon to investigate and report the condition of a small steam-electric power and heating plant. The boiler plant consisted of a 200-hp. B. & W., a 100-hp. B. & W., both equipped with chain grate stokers, and an 80-hp. tubular with plain grate. I made a number of tests on various parts of the equipment and found things in good shape till I came to the boiler setting. Repeated tests of flue gas samples taken from different points of the flue gave quite consistently CO_2—4 per cent; O—16 per cent; CO—a trace.

FIG. 2. POINTS WHERE LEAKS OCCURRED

At the first opportunity, an examination was made of the furnace and a damper placed beneath the stoker of the 200-hp. boiler was found badly warped, leaving an air space about 4 in. wide and 5 ft. long. A new damper was put in and results of tests were better, but about 6 per cent of CO_2 could be obtained, with O, 12 to 14 per cent. The setting was then carefully examined for cracks and tested by holding a lighted candle at the mouth of a box placed against the brickwork as shown. The "pull" on the flame was particularly noticeable at the points marked a, where the brickwork was deflected to allow easy access for cleaning. Numerous cracks, so small as to be scarcely noticeable, were found. All the holes were filled with cement as well as possible.

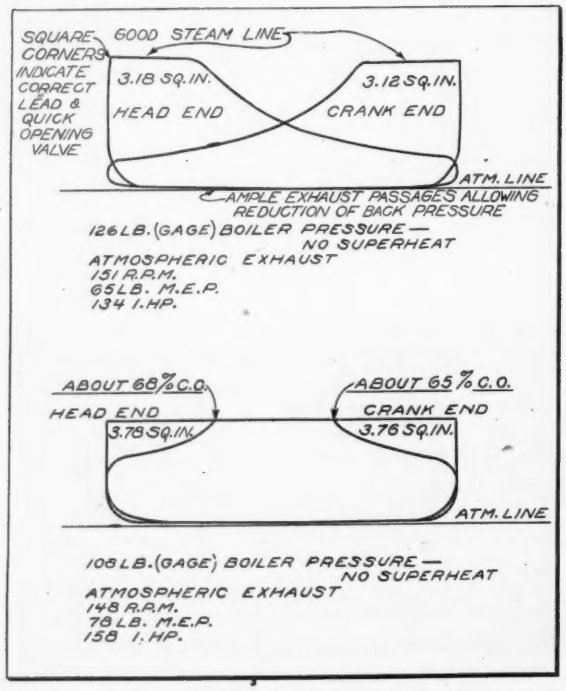
Recent tests give me an average of CO_2—9½ per cent, O—9 to 10 per cent, CO—a trace. There is a noticeable improvement in the operation of the boiler and the coal consumption for the past 4 months is con-

siderably less than for the same 4 months of last year; but as weather conditions are variable and considerable steam is used for heating, this saving cannot be attributed entirely to the correction made. R. S. HAWLEY.

Cards Show Good Engine Design

AMONG OTHER interesting things in the Sept. 15 issue, I read Tom Jones' letter on page 934. The indicator diagrams shown are excellent in every respect, and reveal a first-class condition of affairs in relation to steam distribution in the engine cylinder. The erecting engineer may justly feel proud over the result of his valve gear adjustment and excellent valve setting; evidently he knows his business.

In justice to the designer or designers, as the case may be, however, I feel that something should be said of their work in connection with the matter.



CARDS REPRODUCED FROM SEPT. 15 ISSUE WITH NOTATIONS

The diagrams show, as well as good valve adjustments, good design. This is evident from the nonsloping steam lines, which appear on all the diagrams. In other words, the steam passages, both live and exhaust, were sufficiently large to maintain the pressure up to the point of cutoff, in reference to live steam, and to reduce the back pressure to that of the atmosphere, in reference to the exhaust steam.

It is not often that such symmetrical and correct diagrams can be obtained from an engine, even with the best possible skill in valve setting and adjustment of the gear as a whole; this is because of faulty design. In the present instance, however, there is a combination of skill in design and practical workmanship, that gives ideal results. Therefore, I believe the people concerned in the design of that engine should come in for a fair share of the credit and praise which Mr. Jones bestows upon the erecting engineer. Probably he was thinking only of the valve setting feature of the job, and perhaps considers that entirely aside from the question of design. But had the design been poor in the points to which I call attention, the erecting engineer, with all his skill in valve setting, could not have produced such diagrams as those under discussion,—good diagrams, showing correct design in the engine, good workmanship and skill in the valve adjustments and setting; credit and praise to all concerned. CHARLES J. MASON.

Formula for Line Loss

IN THE solution of problem 16 on page 799 of Practical Engineer for Aug. 1, I believe there is a mistake in the formula for line loss. For 3-phase, 3-wire system, R = resistance per main and I is the current in each main, then the line loss in watts is $3I^2R$ and not $\sqrt{3I^2R}$. To finish the solution, then, 100,000 w. = line loss; 10,000 v. = E.m.f. at receiving end; length of line, 5 miles; power factor, 85 per cent, and current per main = 68 amp.; $100{,}000 = 3I^2R$; $R = 100{,}000 \div (3 \times 68 \times 68) = 7.2$ ohms.

Then, since power transmitted, plus line loss is equal to power generated, in this case,

$$0.85\sqrt{3}\,E_R\,I + 3\,I^2\,R = 0.85\sqrt{3}\,E_g\,I$$

$$0.85\,E_R + \sqrt{3}\,I\,R = 0.85\,E_g$$

$$E_g = 8500 + 847 \div 0.85 = 10{,}996 \text{ v.}$$

E_g = e.m.f. at generator end.

E_R = e.m.f. at receiving end.

Approximate resistance per mile is $7.2 \div 5 = 1.44$ ohms.

From table of B. & S. gage, this would require a No. 4 wire, which has a resistance of 1.33 ohms per mile.

J. C. SCHULTZ.

The Professor and the Gas Engine

CONFESSION, they say, is good for the soul. I believe it, and I also believe that it is good for others to read confessions. I shall therefore confess.

It was this way: Some years ago I was employed out West by a college. My specialty was the teaching of steam and gas engineering. I had studied these subjects for 5 yr. in a well known University, and, naturally, felt competent to tackle anything. In fact, I thought I knew so much about gas engineering that when I obtained permission to visit large manufacturing plants I would dole out advice to the designing engineer or even the chief engineer. By a mere casual glance I could discover an inherent fault in the make-up of the gas engines, or I could point out improvements.

The fact that these engineers listened without a smile and without kicking me out of the plant instilled in me the idea that I was "some pumpkin." Of course I could teach gas engineering; no doubt about it.

The school year began, and I began teaching. Nobody could stump me. I developed the most complicated formulas man had ever beheld before the very eyes of my classes, knowing all the time that those formulas were not understood by the students. I delighted in cloaking simplicity with obscurity. I thought

that the students would think, "He certainly is a deep thinker. There is nothing about engineering that he doesn't know."

Perhaps some of the students did think that. I don't know. But I well remember that I felt the same way when my old professor failed to make me understand. Instead of blaming the professor for not being explicit enough I naturally thought I was not bright enough. And that is why I thought my pupils would regard me in a similar light.

So, in that inefficient way, I taught gas engineering from A to Z. The students learned something, of course, but not so much as they should have learned. The college should have paid more money for an EXPERIENCED gas engineer. A common fault of our colleges and universities is to consider 4 or 5 years' book, laboratory and lecture training sufficient for a teacher. Teachers who have had no experience are usually an abominable thing. They feel "all puffed up." They have never suffered hard knocks. I confess that I believed myself to be pretty wise.

Therefore, at college, I was able to "slip my ability over" easily enough. I made such an excellent bluff during the first year that I was "raised" voluntarily by the departmental head and college president. My parents, brothers and sisters pointed at my photograph with pride and added a sufficiently high percentage to my progress in the world to make our old neighbors stand agape in wonder.

"Who'd a thunk it?" they asked. "Nat always was a-tinkering with machinery."

But, now comes the hard part. I was not entirely isolated from the outside practical world. My fame as a "gas engineer" spread.

There was a 25-hp. gasoline engine in a feed mill in the small town in which the college is located, and it began to act mysteriously. For a year it ran fine, but, as soon as the guarantee was no longer active, it had spells of decided lameness. The owner called me up on the telephone and asked if I would oblige him by "looking 'er over."

I was Johnny on the spot, maintaining, of course, my supposedly dignified bearing. I questioned the owner and operator closely, looked at the engine, listened at the exhaust end, listened at the valves with a pencil pressed against my teeth with ears closed, sagely said this and that, never committing myself, and finally declared that we would use the "college indicator" on the engine.

Clearly, the owner and operator were at my mercy. They knew nothing about indicators. I could as well have talked about the Gemalines on Mars, or Krazazees on Saturn. On me the owner and operator were entirely dependent. That, you see, is what I thought.

The next day I walked pompously into the office of the feed mill with the indicator in its case in one hand and a reducing motion and some piping in the other. I purposely neglected to take one of my pupils along because I wanted all of the honor and glory for myself. I thought the job an easy one and that I could handle it all alone. The owner and operator were mystified already and I proposed to keep them in the same state.

After attaching the reducing motion and piping up the indicator all was ready for the great test. I was the supreme boss—a GAS ENGINE EXPERT. I gave the word to the operator to "start her," and he did. The engine started nicely, picked up speed, seemed to be in perfect condition, and then suddenly had a violent nervous collapse. Maybe you, Mr. Reader, have heard back-fire explosions, but you never heard any like this. It was a terrific cannonade. The operator became so frightened that he shut off the gasoline and stopped the engine. The owner withdrew a few paces. And I believe I must have been a trifle pale myself, for when all was quietness the operator laughed at me in a good humored way.

"What's wrong?" he asked. "That's worse than she's ever acted before."

To have to admit that he doesn't know is a calamity for a young professor. It is worse than sure death. I didn't want to admit that I didn't know and so, collecting my scattered thoughts, I managed to remember that excessive carbon sometimes causes back-firing, and I bravely said, "There must be considerable carbon in the cylinder. I'll look and see."

We removed the cylinder head, but there was no carbon. It looked so clean and the valves fitted so accurately that one would think the whole interior of the engine had been carefully scrubbed and scoured just 10 min. previously, whereas, neither the owner nor operator had ever beheld the interior before. The only thing we could do, therefore, was to put the cylinder head back on, which was no small task. We went to supper, deciding first to come back and work at night, for the feed mill was heavily pressed with work.

By this time, I believe I had lost a great deal of my dignity and pomposity. I realized that this wasn't grandstand work and decided to knuckle down and learn the cause of the mysterious trouble.

On starting the engine again, after supper, the same thing happened. The engine delighted in back-firing, so it seemed.

I took off the igniter—make and break—and looked it over. It looked all right, having just been fitted with a new asbestos gasket. The igniter points were in excellent condition. They sparked beautifully. I therefore put the igniter back and we tried the engine again. Back-firing.

The operator then suggested that I take off my indicator rig to see whether or not the engine would run as well without the rig as it did previously. I debated the point weakly, trying to point out the desirability of obtaining diagrams, for it is the diagram, usually, that bespeaks the internal conditions of an engine. My arguments were overruled, however, and I reluctantly dismantled my contraptions.

Then the engine ran excellently; at least, it ran so much better than with the indicator attached that one would at first call it a perfect engine. Occasionally it would back-fire, but it was not bad. And, to my sorrow, the owner "called me off." He expressed the belief that the engine was irreparable and that he would soon have to get a new one. He was going to enlarge his mill, anyway, he said. Crestfallen, I gathered my belongings together and went home. I didn't have the nerve to charge anything for my work.

A couple of weeks later, while strolling along one of the streets in the small town, I beheld a familiar figure not far ahead of me. It was Fritz Strong, a college classmate of mine whom I knew quite well although we had never chummed any. I was surprised to find him there and he was equally surprised to learn that I had made the little place my abode. I inquired as to the cause of his coming there, and, you can easily believe that he nearly bowled me off my feet when he answered: "Why, to fix the gasoline engine in the feed mill over there back of the livery stable."

He stated that he discovered the cause of the trouble very quickly, being an expert for the manufacturers of the engine. The cause was not an uncommon one, he asserted. The operator, in putting in the new asbestos gasket, had failed to trim the edge properly. The frayed edge projected into the cylinder and naturally became incandescent with each explosion. The asbestos would sometimes retain its incandescence sufficiently long to ignite the fresh mixture, as it was being sucked into the cylinder. Naturally, the only thing that could occur then was—back-fire.

I then confessed to Strong that I had failed to locate the trouble, and Fritz just laughed. He said the owner had said something about a young professor named Near trying his hand at it but failing miserably, and Strong just overlooked the name entirely, never thinking of associating my name or me with a professorship. He was inclined to look at the whole thing as a great joke.

The reason why the engine acted so much worse with the indicator on was that my pipe connection was too long. I have since learned that the shorter the pipe connection, in piping any indicator on any kind of engine, the better. A long pipe, connected with the cylinder of almost any gasoline or gas engine, is an excellent producer of back-firing.

I never told the experience to my class for fear of losing prestige. But, remember, I was young and foolish. Now I have confessed, I feel much better.

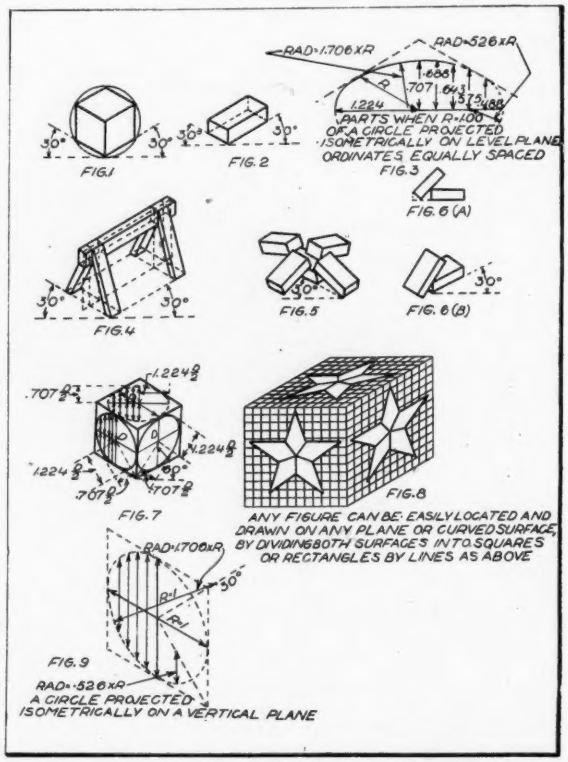
N. G. Near.

Isometric Perspective

One of the most necessary qualifications of an engineer, in almost any capacity, is that of making himself quickly and clearly understood, both by language and drawings, and while most of us can probably more than meet the requirements in drawings, if we are allowed to take our time, yet often all that is required is a free-hand sketch; in fact, with a certain class of men free-hand sketches in more or less perspective are better understood than any other style, and a great many of the ordinary constructions can thus be shown, while in many cases if a scale drawing is needed, one of the isometric perspective type will prove much more useful than any other kind.

To meet the need of having in most condensed form for ready reference just those things that are often wanted when a person is not frequently making such drawings, the writer has put together on one sheet in condensed form just the "pointers" shown, and these too are often useful to hand to an assistant who may have become a little rusty on this subject.

Figures 1 and 2 illustrate the basic principles, while Fig. 4 is a good illustration of the clearness and usefulness of this form of projection. Figures 5 and 6 were published by Mr. Richards some time ago in connection with an article showing how to arrive at the various points mathematically. Figure 7 shows the projection of circles on the 3 planes of the isometric cube, and gives the constants that are most useful in determining the parts of the ellipses, and in Figs. 3 and 9 are given the ordinates of these ellipses, and also the ratios of the radii of a "3-point oval drawn with compasses" to the isometrical radius of the circle. This will approximate very closely the isometric projection of the circle, closely



SAMPLES OF ISOMETRIC PERSPECTIVE DRAWINGS

enough, the writer considers, for most of the everyday drawings, thus simplifying the most troublesome part of isometric perspective, which we hope will lead to its more common use.

For some particular items, the method shown in Fig. 8 appears to be the quickest and best; it will also apply to some work that is not isometric, so it has been included with the other "pointers."

Men engaged on construction work in the field particularly can often use these methods to great advantage, greater clearness, less danger of mistake or misunderstanding, with less verbal or written explanation and a saving of time.

F. W. Salmon.

Views illustrating the use of "American" deep well turbine centrifugal pumps for water works pumping, are shown in a circular lately received. These pumps are manufactured by The American Well Works, Aurora, Ill.

Minnesota Examinations

As to some of the points raised by A. C. Brown in the Oct. 1 issue of Practical Engineer, page 976, my impression that one year's power plant service entitled a man in Minnesota to a first-class license, came from the experience of 3 members of my family who have taken the examinations. Each one was asked if he had a year's experience, and from that I took it that this was the law.

In regard to the point he raises, that the Minnesota examiners do not hold to any one set of questions, my father, myself and my youngest brother have all taken the examinations and found that the questions varied in form and order, but covered essentially the same points.

As to the matter of passing the examinations by knowing the answers to a fixed set of questions, I certainly give the inspectors credit for having brains enough to detect whether the applicant is a novice or whether he really knows his subject. F. M. J.

Safety Device for Gate Valve Handles

Some time ago, the writer was repairing a pump in a refrigerating plant. In the boiler room, it happened that some trouble occurred in connection with the water line to one of the boiler nests. A stoker not familiar with the pipe lines, but at the same time trying to remedy the water trouble, opened a wrong valve, severely scalding a number of men working with the writer on a hot-water pump.

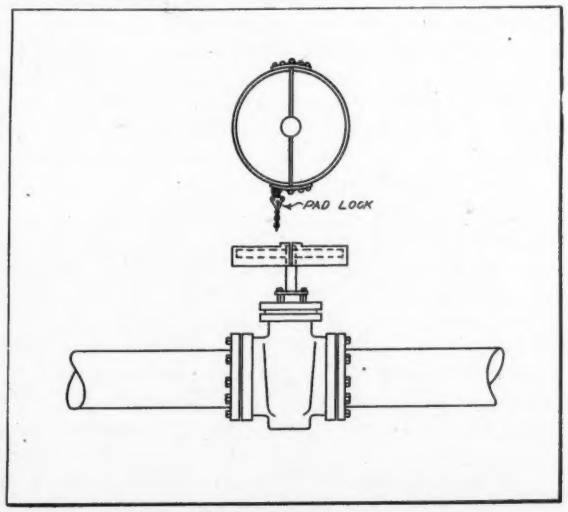


FIG. 1. MANNER OF PLACING SAFETY DEVICE

The manager saw that the stoker, though in a way to blame, could not be held absolutely responsible because of his lack of knowledge concerning the lead of the valves; for, through initiative, he was doing the best he could without consulting the chief. The sketch is descriptive of the manner in which steps were taken to prevent any similar occurrence. A loose guard cap, built in hinged half sections slightly larger than the diameter of the valve handles, was placed over them. The material was of heavy galvanized sheet-iron, and the arrangement protected by a padlock. It was impossible to turn the valves by hand with the device over the handles, and those informed as to their purpose were the only ones possessing a set of keys to get at them.

On the tops of the guards were indicated the nature of the valve and its purpose. There are, of course, a number of ways to prevent tampering with the large class of valves; but in the writer's opinion, this is as neat, efficient and inexpensive an arrangement as could be used for the purpose. If uninformed help should

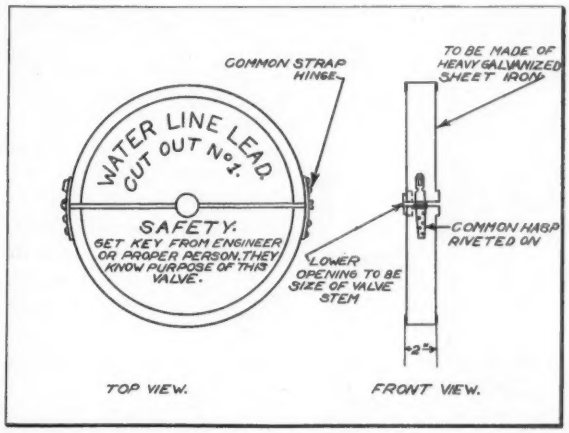

COMMON STRAP HINGE
TO BE MADE OF HEAVY GALVANIZED SHEET IRON
WATER LINE LEAD CUT OUT No. 1.
SAFETY.
GET KEY FROM ENGINEER OR PROPER PERSON. THEY KNOW PURPOSE OF THIS VALVE.
LOWER OPENING TO BE SIZE OF VALVE STEM
COMMON HASP RIVETED ON
2½
TOP VIEW.
FRONT VIEW.

FIG. 2. FRONT AND SIDE VIEW OF SAFETY DEVICE

be required to look for or manipulate a valve, the numbering or lettering will inform them as to what is to be accomplished before procuring the key of the guard from the engineer or assistant, who in this way will know exactly what valves are being cut in or out about the plant. F. W. Bentley, Jr.

Pump Troubles

Two large centrifugal pumps were installed so that their discharge pipes led to the same main. The occasion arose when it was thought that one pump could handle the required amount of fresh water, while the other could assist the supply by pumping white water from a tank which caught all the water flowing from wet machines.

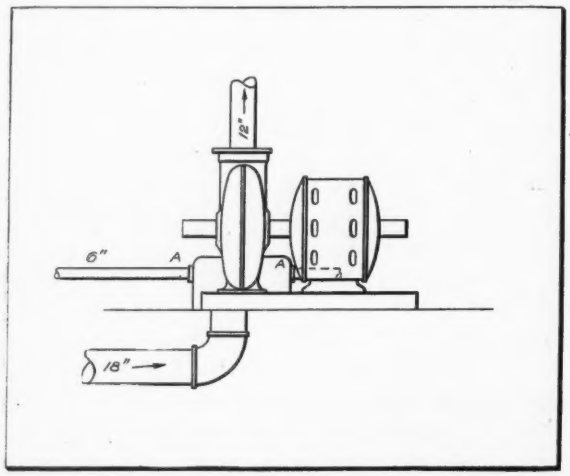
After the change was made, it was noticed that each pump, when running at full speed, gave out a shrill humming noise, varying in tone. This change in tone occurred at periodic intervals. Before the change, pressure gages on the pumps showed 40 lb. pressure, but running separately the gage fluctuated from 15 to 20 lb. As the guides and runner of a centrifugal pump have small openings, it was thought that the pumps became plugged, but nothing was found upon opening them.

One day, while watching the pump's actions, trying to discover a remedy, the cover of the suction tank supplying the fresh water pump was removed, so as to view the suction riser. At the time when the pump's tone was loudest a large whirlpool formed over the suction and when the tone dropped, the whirlpool closed and a back rush of water boiled up, showing that the pump did not get enough water. The suction pipe was large enough for a 12-in. pump, being 18 in. in diameter; but where it joined the pump it was throttled down, decreasing the area entering the guide chamber about half.

It was manifestly impossible to change this throat, as it was cast with pump shell. To make sure that a par-

tial vacuum was formed at this point we tapped an inch hole and screwed on a valve. Upon opening this valve and placing one's hand over the pipe, a strong suction was discovered. The remedy was then to put more water into the pump.

On each side of the pump, the suction pipe widened into 2 chambers at A. These chambers were drilled for a 6-in. opening and 6-in. pipes bolted on. These pipes were carried to the suction tank.



PUMP WHICH GAVE TROUBLE, AND REMEDY

When the pumps were started under the new arrangement, the pressure immediately rose and the humming ceased, showing conclusively that the throat as cast by the makers was too small to allow the calculated amount of water to enter the vanes. The pumps being direct connected to motors on the same base, evidently no trouble was due to slipping belts. R. H. BROWN.

Two Engineers

HERE IS the plain story of 2 engineers. It contains a lesson, but no moral will be drawn up. If the plain story won't suffice a diagram would be superfluous.

Pene Hammer Bill was monkeying with a motor one day. His fireman was helping him, and being a wide-awake chap, took occasion to learn a little. One thing Bill did excited his interest. He did not understand the move. So he asked, "Is that right?" It was curiosity that prompted him, but Bill took it as criticism. Anyway, the fireman never found out. A string of profanity, a reminder that the fireman was there to help not to butt in, that it was a good man who knew his place, etc., and "I guess I am still capable to run this joint," and more. So the fireman subsided.

But his turn came. A few weeks later the gasket above the throttle on the engine that ran the lights blew out. Bill needed assistance in the work, so he called in the fireman. About the time the old gasket had been cleared away there came a call for lights. Bill hastily cut another gasket and put it in. While the fireman was fixing the oil cups Bill prepared to "get her goin'." The throttle was opened, but she didn't budge. They turned her by hand. She went freely, but stopped very dead. Cursing, Bill went over all his valves again. Everything seemed all right, and he opened the throttle again. Again no response. More whirling of flywheel. No go. Looking around suddenly in his excitement, Bill caught a smile on the fireman's face.

"Do you know what the matter is?"

"I do."

"Well, why didn't you say so, not stand there grinning like an idiot?"

"You see, Bill, I'm only a fireman, I know my place. I don't like to butt in, and only a few days ago you told me you were fully capable of running the place."

Run into his hole, Bill mollified a bit.

"Well, for the love of Pete, tell me what it is."

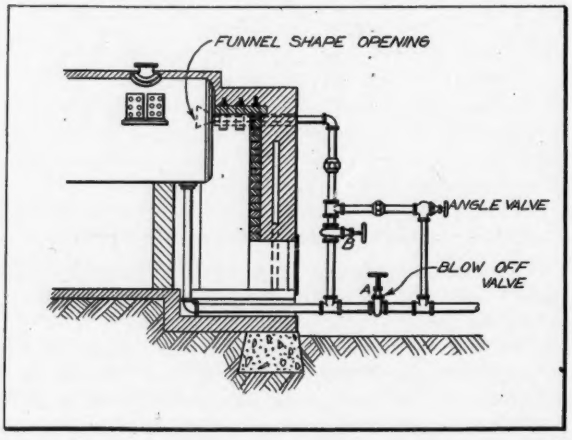
"I suppose I was a fool," said the fireman telling the story, "but I pitied the cuss and told him. He had put in the gasket without cutting a hole for the steam. The pipe was small and the packing held."

Slide Rule John sat at his desk puzzling over some details of last month's report sheet. On the calendar pad before him were half a dozen items not yet checked off, and yet it was nearly time to quit. One of the firemen entered. "That new pump governor you put on No. 7 is no good," he said. "I've been bothering with it all day, but it's getting worse instead of better." There was a tone to this that some might have taken for fault-finding, but John knew it was only lack of tact. There was no cursing, no waste words to the effect that "I'm too busy just now." John just led the way back to the pump room and there on the wall, among the various frames containing rules, directions, etc., he chose the one that contained a cut of the new governor, together with a set of directions. From the cut John explained the whole operation, asked a few questions, showed the fireman just where he had bungled in his "bothering," and left him with the admonition that he had better look over all the other "pictures" and "polish up."

WILLIAM E. DIXON.

Circulating Pipe Connections

BEING A fireman and engineer of 5 yr. experience, I enclose what I think is an addition to the sketch of circulating pipe, on page 918, Sept. 15 issue, which is



CIRCULATING PIPE IN CONNECTION WITH SURFACE AND REGULAR BLOWOFF

very good, and in addition to it I would call it a surface blowoff also. E. W. BARTON.

Questions Answered and For Answer

Expert Help When In Trouble. If You Want Quick Answer Enclose a Stamp

Fuel Consumption of Ice Plants

I WOULD like to ask if you could give me some data on fuel consumption of ice plants, preferably of 5 and 10 tons capacity per 24 hr. Would like to know average consumption of such plants using medium grade of coal, return tubular boilers, Armstrong insulating brick in furnace settings, piston-valve engine direct connected to compressor, distilled water used in filling cans. Would exhaust from engine be sufficient to supply condensed water? If not, would an evaporator be a profitable investment with coal at $3.50 a ton?

J. B. W.

A. In an ice plant of 5 or 10 tons capacity per 24 hr., the steam consumption of a piston valve, simple noncondensing engine would be sufficient to supply all the distilled water required for that quantity of ice, provided the waste is not allowed to exceed the 20 per cent estimated for ice plants of small capacity.

In cases where the engine does not supply sufficient "sweet water," the deficiency may be made up, either by the use of an evaporator, as suggested, by allowing steam from the boilers to pass through an auxiliary line direct to the steam condensers, or, what is more commonly done where reasonably pure water is available, by admitting raw water into the condensing system either at the reboiler or into the exhaust steam line or steam condensers. By this treatment, a part of the raw water is evaporated, or it is at least heated to such a temperature as to cause a precipitation of some, though not all, of the impurities.

With the small amount, if any, of "makeup" condensing water required for a plant of so small a capacity, we do not believe the use of an evaporator either necessary or advantageous from an economic standpoint.

The fuel consumption of all, and especially small sized ice plants, is subject to such wide variation, that it is impossible to give more than general figures which will agree with actual results, directly in proportion to the agreement between the assumed and the actual conditions.

A plant of 10 tons daily capacity will obviously require 10 tons of distilled, or distilled and raw water to fill the cans, which increased by the 20 per cent assumed waste between the boilers and the ice can, makes the total water consumption 24,000 lb., or 12 tons. If the coal employed will evaporate 5 lb. of water, the coal consumption of a plant requiring 12 tons of water would obviously be 2.4 tons of 2000 lb. If the coal has a heat value such that it will evaporate, under the actual conditions, more or less than the 5 lb. assumed, the amount required will be respectively less or more.

The use of insulating bricks in the furnace setting will have much less effect on the fuel consumption of the plant than many other factors, the value of which is not stated.

Kent, in his Mechanical Engineers' Pocket Book, gives an example which will suffice. In a boiler plant operating at, roughly, 70 per cent efficiency, the total per cent radiation determined by taking the difference between losses accounted for, such as heating of flue gases, evaporation and superheating of aqueous vapors, losses by incomplete combustion, etc., and the total losses (roughly 30 per cent) was found to be 4.31 per cent.

Now, a change in initial temperature of condensing water from 60 to 85 deg. F.,—for example, when the back pressure is 15 lb., would make an increase in coal consumption, in case of a Corliss engine, of 14 lb. (practically 10 per cent) per ton of refrigeration per 24 hr., or assuming 1½ tons of refrigeration are required to produce 1 ton of ice, and that a slide valve engine is employed instead of a Corliss, the increased coal consumption per ton of ice produced would be 28 lb.

Again, an increase in back pressure of from 15 to 20 lb., when the initial temperature of the condensing water is 60 deg. F., produces a reduction of coal consumption, in the case of a Corliss engine, of 18 lb. per ton of refrigeration, or for a slide valve engine, 36 lb.

From the above, it may be readily seen that when these and many other conditions vary simultaneously, it is impossible to give more than general figures.

Siebel's "Compend of Mechanical Refrigeration and Engineering" gives $3 as the cost of coal in a 20-ton ice plant. At the stated price of $1.10 per ton, this would mean 2.7 tons per 20 tons of ice or 7.4 tons of ice per ton of coal.

A. P. Criswell, of Chicago, in a paper on "Cost of Making Ice," read before the American Society of Refrigerating Engineers in 1909, gives a table in which he shows the coal consumption of small ice plants to be 1 ton per 5 tons of ice produced.

In the above examples, neither the evaporative power of the coal nor the type of engine is stated; but we may assume that the respective authors refer to total coal consumption of plants.

One of the leading manufacturers of ice machines gives the following somewhat more definite information:

The fuel consumption of ice-making machines of the compression type driven by slide valve engines and operating at a back pressure of 15 lb., and a head pressure of 180 lb.,—that is with cooling water at a temperature of from 65 to 80 deg. F., according to the number and type of condensers used, under which conditions the m.e.p. of the compressor would be 63.4 lb., and

the i.hp. of the engine and compressor would be 1.75 and 1.52 per ton of refrigeration produced,—would be 198 lb. of coal per ton of refrigeration per 24 hr. Assuming 1½ tons of refrigeration is required to produce 1 ton of ice, the coal consumption would be 297 lb. per ton of ice, or, for a 10-ton plant, about 1½ tons of coal, on which basis the ice production per ton of coal would be 6⅔.

For convenience, these figures are based on an evaporation of 10 lb. of water per pound of coal, which is much better than can be realized with coal of average heat values. For coal having a known evaporative value, however, the correction is easily made. If, for example, it is found that the coal in question has an evaporation of only 7 lb. of water per pound of coal, the coal consumption per ton of ice will be $1\frac{1}{2} \div 0.70 = 2.14$ tons, and the ice production per ton of coal will be $6\frac{2}{3} \times 0.70 = 4.66$ tons. F. E. MATTHEWS.

Boiler Measurements

KINDLY INFORM me where to measure the diameter of a Manning boiler when determining the safe working pressure; there is a considerable distance above the staybolted part of the water leg to the top of the wide part, where it turns in to the shell. I understand that the staybolted water leg has to be figured separately and compared with the shell part of the boiler like a return-tubular boiler, but what puzzles me is where to take my radius on account of the part mentioned. What would make the receiver pressure unduly high on a cross compound Corliss engine? W. N. R.

A. The diameter of the Manning boiler taken to determine the safe working pressure of the shell would be in the upper part, where it is not staybolted. Even though there may be considerable distance above the staybolts, this will be largely supported by the staybolts, and also by the reverse curve ring between the different diameters.

As to the cause of the receiver pressure rising, this is almost impossible to answer without being able to study the working conditions in your plant. Where the load is constant, the receiver pressure depends on the low-pressure cutoff. The shorter the low-pressure cutoff, the higher will be the receiver pressure. If the load is variable, the heavier the load, the higher will be the receiver pressure; so that the rise might be due, if the cutoff on the low pressure cylinder is variable, to the fact that the cutoff is advanced too rapidly by the governor, or it might be due to the usual effect of an increasing load. A. L. R.

Eccentric and Governor Questions

How is the eccentric set for an engine running under?

2. What are the advantages of 2 eccentrics on a Rollins engine?

3. What would happen should one of the balls drop off from a governor? M. R.

A. The relative location of the eccentric and the crankpin in order to make the engine run in a given direction, depends entirely on the details of design. To go back to the early principles of the plain "D" slide valve, which admits steam past the ends of the valve, and upon which all other types of valve gear are in fact but a change or an improvement, one must understand this valve and principle of its operation and construction thoroughly, in order to grasp fully the many more or less complicated valve gears which have appeared on the market from time to time.

With a plain slide valve, driven directly from the eccentric and with no intervening connections—that is, with the eccentric rod attached to the valve stem at the guide—the eccentric always leads the crankpin in the direction in which the engine runs, no matter whether it is over or under.

Now, if through design, it is found inconvenient to operate the valve as above, a carrier arm is inserted between the eccentric and the valve in one of 2 ways, or slight modifications of them.

First. The carrier arm may be what is called "direct," similar to Fig. 1, in which case the eccentric still leads the pin as cited above. If the carrier arm is as in the sketch, it increases the motion of the eccentric at the valve which is exemplified in many of the Corliss engines of simple design. If it is not desired to increase the motion of the eccentric, the design is similar to Fig. 2.

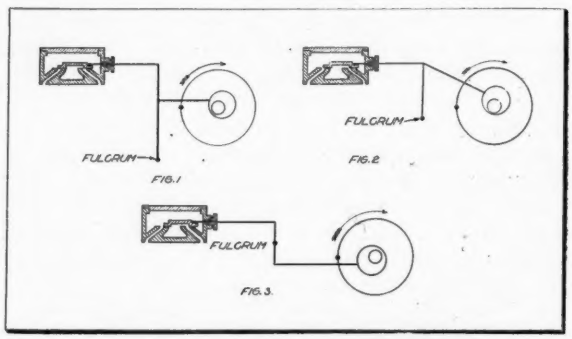


FIG. 1. ECCENTRIC LEADING CRANKPIN
FIG. 2. WHEN IT IS DESIRED NOT TO INCREASE ECCENTRIC MOTION
FIG. 3. ECCENTRIC FOLLOWING CRANKPIN

Second. The carrier arm may be what is called "indirect," as shown in Fig. 3, in which case (other things remaining the same) the eccentric follows the crankpin in the direction in which the engine runs. This indirect carrier arm may change the relative travel of the valve and the eccentric or not, depending on conditions. Locomotives with inside valve motion use carrier arms like this.

On Corliss engines with single eccentrics, as a rule, the conditions are the same as in Figs. 1 and 2 if the hook rod is attached to the top of the wristplate; but if the hook rod is attached to the bottom of the wristplate, the position of the eccentric will be the reverse of that shown in the same sketches.

To go back to the plain slide valve again dealing briefly of the other complications that may arise: In some designs of valve, whether of the piston or flat type, the steam is admitted at the middle of the valve and exhausted past the ends—just the reverse from the "D" valve. So, if a valve of this type be used (other

things remaining the same), the position of the eccentric with reference to the crankpin will be the reverse of that shown in the sketches.

Then, when you begin to work out the various combinations of the different valves, carrier arms, etc., it soon becomes bewildering unless one has the principle of the slide valve and its connections well in mind.

2. Two eccentrics on a Rollins engine, or any make of an engine with either 2 or 4 valves for handling the steam in and out of the cylinder, permit a flexibility of adjustment that is not possible if these several events are handled by one eccentric.

With one eccentric, the limit of cutoff is about 45 per cent of the stroke, and at best, perfectly ideal conditions are not obtainable as some events must be partially sacrificed to permit others to be at least partially attained.

With 2 eccentrics, the steam valves can be adjusted without reference to the exhaust valves, and vice versa, under which conditions, by reducing the lap of the steam valves, the steam eccentric can be retarded so far that a maximum cutoff of 80 per cent of the stroke can be obtained. It is not maintained that this is economical, but it permits peak loads to be carried successfully with complete regulation.

3. Here is another instance where one must know more of the local conditions. If the governor has either a spring or a dead-weight counterpoise and one of the balls falls off, it will require a higher speed for the remaining ball to have centrifugal force enough to raise the counterpoise. If there is no counterpoise and the weight is all in the balls, the loss of one of them will cause but little variation in speed.

In the numerous types of throttling governors now being used, one must also have more definite knowledge of conditions. GEO. H. WALLACE.

Position of Keyway; Amount of Current

IS THERE any particular point on the shaft for keyway?

2. What is the amount of current in amperes used by the different types of lamps on a 110-v. circuit?

A. The positions of the key and keyways are always governed by the strength of the material. It is always practicable to place the key and keyway in the strongest part of the material.

2. Incandescent lamps are rated as to the voltage of the line on which they are to operate, and also as to the amount of electric power they consume. A carbon filament lamp may be rated at 110 v. and 50 w., or a tungsten lamp may be rated as a 110-v., 25-w. lamp. This means that both lamps are intended to run on a 110-v. circuit, but that it takes twice as much power to keep the carbon filament lamp glowing. The flow of an electric current is analogous to the flow of water through a pipe. A current of water is measured by the number of gallons or pounds flowing per minute and a current of electricity by the number of amperes or coulombs per second. The power required to keep a current of water flowing is the product of the current in pounds per minute by the head, or pressure in feet. This gives the power in foot-pounds per minute. To reduce horsepower to foot-pounds it is necessary to divide by 33,000; i.e., lb. per min. $\times$ ft. $\div$ 33,000 = hp.

In exactly the same way, electrical power is the product of current in amperes by the pressure in volts. This gives the power in watts; i.e., watts = amperes $\times$ volts. A watt is merely a unit of power, and denotes the power used when one volt causes one ampere of current to flow.

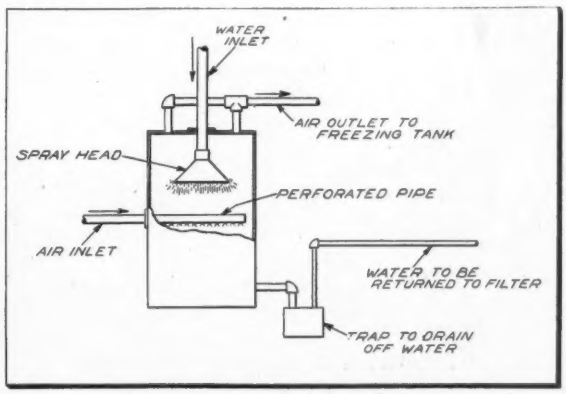
The watts consumed when any given current flows under any pressure can always be found by multiplying the current in amperes by the pressure in volts. Thus, if an incandescent lamp takes 0.5 amp., when on a 110-v. line, the power consumed is equal to $0.5 \times 110 = 55$ watts = amperes $\times$ volts.

Just as Ohm's law is used in 3 forms, so the power equation is also used in 3 forms; i.e., watts = amperes $\times$ volts, the amperes = watts $\div$ volts. The power equation then has these 3 forms: To find power, watts = amperes $\times$ volts; to find current in amperes, divide watts by volts, and and to find voltage, divide watts by amperes. That is, a 25-w. lamp on a 110-v. circuit will take 0.227 amp., as amperes = watts $\div$ volts, or $25 \div 110 = 0.227$ amp. H. P. ROBBINS.

Refrigeration Problem

WE HAVE the plate system of manufacturing ice here and we blow air direct from the compressor into the tanks at about 5 lb. pressure. Would it not be better to install a set of coils in one of our sharp freezing rooms and pass the air through these coils before it reaches the tanks? W. C. K.

A. I would not advise you to install coils in a sharp freezer to pass air through, as the moisture that the air carries would be deposited in the shape of frost on the inside of the pipe, and in a short time would form such an insulation that there would be but a very little cooling done. This frost would also keep on accumulating until the pipe coil would become entirely filled with frost and ice.



SPRAY SYSTEM FOR COOLING AIR

In most plate and raw water systems, the air is cooled in some manner: some use a double-pipe cooler through which cold water is passed; this will cool the air down to the temperature of the water. This water may be taken direct from the well, or from the freezing tank, and in either case or system you should provide some means for draining the moisture that will accumulate.

Another system that is used is the spray system, this consists of a vertical tank in which the air is brought in direct contact with cold water, which is usually taken from the freezing tank as shown in the sketch. This is an effective method of cooling air before entering the tank. All cooling apparatus should be placed as near the freezing tank as possible to avoid reabsorption of heat by the air on its way to freezing tank.

W. H. BIESLEY.

Catechism of the Corliss Engine*

WHAT OBJECTION is there to lengthening the exhaust radial rods to get compression?

A. While this would certainly give the exhaust valve earlier closure and the engine the necessary compression, the exhaust valve would, however, be late in opening; in fact, the piston would reach the end of its stroke before the exhaust valve opened.

33. How, then, will we get the necessary compression?

A. By advancing the eccentric. This will make the release and compression take place sooner. It will also make the lead earlier. For this reason, lap is given to the steam valve; in other words, to hold the steam valve closed during compression.

34. About what amount of lap is generally given the steam valves?

A. The following table gives the position of the steam and exhaust valves with the wristplate in its central position:

Size of engine	Steam lap	Exhaust opening
12 in.	1/4 in.	1/32 in.
14 "	5/16 "	1/32 "
16 "	5/16 "	1/32 "
18 "	3/8 "	1/16 "
20 "	3/8 "	1/16 "
22 "	3/8 "	1/16 "
24 "	7/16 "	3/32 "
26 "	7/16 "	3/32 "
28 "	7/16 "	3/32 "
30 "	1/2 "	1/8 "
32 "	1/2 "	1/8 "
34 "	1/2 "	1/8 "
36 "	1/2 "	1/8 "
38 "	9/16 "	3/16 "
40 "	9/16 "	3/16 "
42 "	9/16 "	3/16 "

35. How is this amount of exhaust valve opening given?

A. By adjusting the exhaust radial rods, while the wristplate is in its central position.

36. What will be the effect upon the "range of cutoff" if we advance the eccentric?

A. It will reduce the range of cutoff.

37. Where is negative lap used?

A. On a double eccentric engine, the steam valves are open when the valve gear is in its central position. This is negative lap.

38. Where should the dashpot plunger be when the steam valve is given lap?

A. It should be in its lowest position.

39. Where should the wristplate go when the valves are given lap?

A. It should be in mid-position, center marks should be line and line.

40. What effect has excessive lap upon a Corliss engine?

A. It reduces the rapidity of the valve movement at the point of opening, and decreases the range of cutoff.

41. Why is exhaust lap given the exhaust valves?

A. To insure a tight valve, and sometimes with the double eccentric engine, to give a later release and earlier compression.

42. Explain how the governor acts upon the cutoff?

A. As the governor weights are thrown out by the speed of the machine, the governor acts through its mechanism (explained later) upon the reach rods, and causes the trips to trip the valves, thus bringing cutoff earlier.

43. How is the cutoff equalized?

A. By blocking up the governor to running position, and lengthening or shortening the reach rods.

44. How is the correct length of the dashpot ascertained?

A. If the rod is the right length, the valve will pick up at the beginning of the engine stroke.

45. Why cannot the exhaust valve closure be made earlier by means of the radial rods?

A. If this is done, the valve opening will be reduced, which will increase the back pressure upon the engine.

46. What will cause the valves to fail to trip?

A. Governor reach-rods not the right length. Governor on the safety, due to low steam pressure.

47. What will cause the valves to remain open after they have tripped?

A. Tight packing on the valve stems, dashpot rods too long, or the compression in the dashpots may be too great.

48. What will cause the valves to fail to pick up?

A. Latch edges or the block edges worn, safety cams acting upon the valves or the latch spring may be broken.

49. What may be done if the latch block is worn so that valve fails to pick up?

A. The wear comes only on one edge of the block so if the block is turned a new edge can be used.

50. How may the engine be run one-ended?

A. Block open exhaust valve and block shut steam valve, then raise the steam pressure.

51. Where does the governor rest in setting the valves, and why?

A. On the stop-motion pin. It should be remembered that the governor has nothing to do with the valve setting, except in the adjustment of the cutoff.

52. Why is a stop-motion pin used?

A. With the governor in its lowest position, valves would not pick up, being tripped by the safety cams. Stop-motion pin prevents the governor going to its lowest position.

53. Should the stop-motion pin be left in with the engine running?

A. No. As soon as the engine is up to speed, the stop-motion pin should be removed and replaced just before the engine is shut down and after the steam is shut off.

A. D. PALMER.

(To be continued.)

*Continued from page 985, Oct. 1 issue.

Coils in Watt-Hour Meter

WHAT IS the purpose of the potential coil in a watt-hour meter used on an alternating-current circuit?

What is the purpose of the current coil? Why are 2 separate coils employed—a current and potential coil?

V. K. S.

A. Replying to your question as to the parts of the integrating watt-hour meter, the watts in any circuit, as you know, are equal to the volts times the amperes. When we measure volts and amperes in an alternating-current circuit by voltmeter and ammeter, we get an averaged value, and in order to get the watts, we must multiply by the cosine of the angle of lag or the power factor.

In the case of a wattmeter, we send through the current coil either the total current or a shunted current, which is proportional to the total amount. Through the potential coil, which is joined between the leads, passes a current proportional to the voltage. The wattmeter is arranged so that the 2 coils, potential and current, are free to act on one another, and this action is proportional to the product of the currents flowing. As one current is proportional to the amperes in the main circuit, and the other current proportional to the volts in the main circuit, the product of the 2 is proportional to the watts.

In the watt-hour meter, we introduce the time element, or the speed of a revolution of a proper disk, and in this way get the 3 factors, the volts, the amperes and the time.

A. L. R.

Air Compressor Calculations

WILL YOU please give me a rule for calculating the horsepower of a single stage air compressor?

C. S.

A. The indicated horsepower of an air compressor may be found by the formula used for steam engines,

$$PLAN \div 33{,}000;$$

where P = the mean effective pressure in pounds per square inch;

L = the length of stroke in feet;

A = the net area of the piston in square inches;

N = the number of working strokes per minute.

According to Mariotte's Law, the mean effective pressure $P = P_1 \times (1 + \text{hyperbolic logarithm } R) \div R$; where P_1 = the absolute discharge pressure, and

R = the ratio of the absolute discharge pressure to the absolute suction pressure.

L. N. B.

Criticism of Corliss Engine Cards

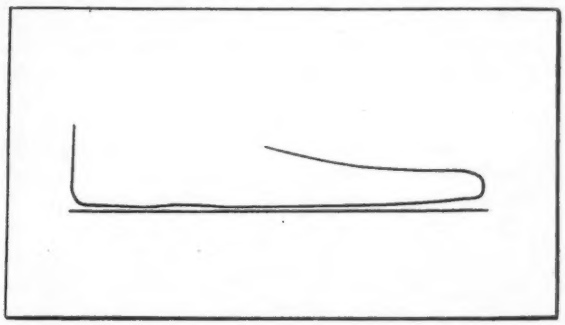
IN REGARD to the cards shown by H. E. S., on page 986 of Oct. 1 issue, as Lane and Bodley engines of the usual construction are provided with 2 eccentrics, the exhaust valves may be adjusted independently of the steam valve adjustment; so if he will equalize the travel of the exhaust rocker arm by the adjustment of eccentric rod and then set the exhaust eccentric so that the exhaust valves are line and line, he will obtain an earlier opening.

There is nothing gained in carrying the expansion to the end of the stroke, and better all-round results are obtained when release occurs a little before the end of the stroke, since the forward pressure on the piston will have less resistance to overcome and the reciprocating parts can have the pressures reversed with less shock and quieter running is obtained.

The radial steam rod to the crank end steam valve should be changed to give an earlier opening, while the head end steam rod should be moved to retard the admission slightly. The cutoffs are not square yet; perhaps, due to leakage, the same power is developed in each end of the cylinder. When changing steam radial rods, take the precaution to move the valve gear through the full travel in each direction, to be sure the dashpot rod is not too long, also to readjust the knockoff rods, since any change of radial rods will move the steam hook in relation to the knockoff cam.

The governor should be blocked in the highest and lowest position and the safety cams set so the steam valves will not open up at all even if the hooks engage, as in some motions.

RECEIVER.



SUGGESTED IMPROVEMENTS IN ADJUSTMENT

H. E. S. HAS certainly made a great improvement in the valve adjustment of this engine as shown by the diagrams; the work is not finished but a few small adjustments as explained herewith will make the engine show a first class diagram.

Both ends show late release and compression fair, also late admission particularly on the crank end.

Change the length of exhaust valve rods so as to make release earlier; this will make compression less, but that will come back again by our next adjustment. I would suggest that the length of the exhaust rods be altered almost enough to lose the compression; this will bring the release a lot earlier. Now advance the eccentric on the shaft, say ¼ in.; this will make release, compression and admission earlier. Adjust the position of the eccentric on the shaft and length of exhaust valve rods until the release and compression are correct; when these 2 events are correct, I think the head end admission will be too early and the crank end about right. These can be corrected by altering the length of the steam valve rods and dashpot rods so as to get admission correctly and proper working of latch hooks. The adjustment trip cams for equal points of cutoff will then complete the work and should give a fine diagram.

H. W. BENTON.

PRACTICAL
ENGINEER

Trade-mark reg. U. S. Pat. Office.

PUBLISHED ON THE FIRST AND FIFTEENTH OF EACH MONTH
At 537 So. Dearborn Street, Chicago, Ill., by the
TECHNICAL PUBLISHING CO.
New York, 150 Nassau St.

Notify us at once of any change of address, giving the old and the new address, so that your paper may always reach you promptly.

Copyrighted, 1914, by Technical Publishing Co.
Entered as second class matter May 1, 1908, at the Post Office at Chicago, Illinois, under the Act of March 3, 1879.

Circulation of this issue. 22.500.

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Heat and Cold Insulation

At first thought, it would seem that the substance which will best prevent escapes of heat from a hot pipe would also be best to prevent absorption of heat by a cold pipe; but experiments recorded by Prof. W. M. Thornton, as given in Engineering, indicate that such may not always be the case. Conductivity of insulating materials varies with the temperature, increasing as temperature increases in the case of charcoal, air and baked cork and decreasing with increase of temperature for slag wool. Presumably there is variation of like character in other substances, but the experiments mentioned did not include them.

At all temperatures up to 200 deg. F., still air is the best insulator of the 4, but to hold it still and prevent currents some method must be found of forming air cells, and a granular or porous substance seems the most convenient. At 80 deg. F., cork and slag wool are about on a par; above that, the wool has the advantage, and below the cork, hence the wool is the better for heat insulation, and the cork for cold insulation. Further data on other substances used for such purposes are desirable.

There is another property that has a bearing on the problem where large amounts of insulating matetrial are used as for refrigerating rooms and ice tanks; i.e., the specific heat of the materials. With temperature variation, the insulation itself may take up or give out a considerable quantity of heat, and it is desirable to keep this variation as small as possible. The best material will be that which has a minimum conductivity at the temperature to be maintained, combined with a high specific heat, so that the insulation may act as a steadying factor to avoid sudden fluctuation of temperature when the external temperature changes quickly. Of the 3 solids mentioned, charcoal has the highest specific heat, cork next and slag wool least; but the conductivity of charcoal is so much greater than that of cork that this advantage is neutralized. Here again, more data as to specific heat of insulating materials will be helpful, and should be made available by the researches of our technical schools and experiment stations.

Commercially, the cost of the materials and of applying them must be considered, as a cost of cork double that for slag wool would put them practically on an equality for insulation at 32 deg. F. As in all engineering problems, it is a question of getting the best returns per dollar invested, both as to material and thickness of insulation to be used. Thicker insulation means less heat transfer; but above a certain point, the increased first cost and upkeep overbalance the saving in cost of heat wasted. And the most economical point must be determined for each case on the basis of cost of installation vs. cost of energy.

AFTER SEVERAL MONTHS of active preparation in building and installing machinery, the big ice and cold storage plants to be operated by Noel & Co., at Tenth and Johnston avenues, Nashville, will be open for service within a few days. The ice plant has been in operation for several months and is fully equipped.

STATEMENT OF OWNERSHIP, MANAGEMENT, CIRCULATION, ETC.

of Practical Engineer, published Semi-Monthly at Chicago, Ill., required by the Act of August 24, 1912.

NOTE.—This statement is to be made in duplicate, both copies to be delivered by the publisher to the postmaster, who will send one copy to the Third Assistant Postmaster General (Division of Classification), Washington, D. C., and retain the other in the files of the post office.

Name of— Post-Office Address—

Editor, Arthur L. Rice, 537 S. Dearborn St.
Managing Editor, Arthur L. Rice, 537 S. Dearborn St.
Business Manager, E. R. Shaw, 537 S. Dearborn St.
Publisher, Technical Publishing Co., 537 S. Dearborn St.

Owners: (If corporation, give names and addresses of stockholders holding 1 per cent or more of total amount of stock.)

E. R. Shaw, 537 S. Dearborn St.
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Chas. Sanford Clarke, Sec'y.

Sworn to and subscribed before me this 15th day of September, 1914. Warren A. Lathrop, Notary Public.

News Notes

THE WHEELER CONDENSER & ENGINEERING CO., of Cartaret, N. J., is now erecting several large cooling towers. This includes 2 large contracts, one for a single tower for 600,000 gal. per hr. capacity, and also a battery of towers, having a capacity of 600,000 gal. per hr., both for operation in connection with surface condensers and turbines. Besides the large units many medium and small sized condensing equipments with cooling towers are being furnished.

What is probably the largest cooling tower project ever undertaken was supplied for the Texas Power Co., Waco, Texas. These towers are of the steel shell type, arranged in a battery 100 ft. long, 18 ft. wide and 40 ft. high. There are 6 pairs of 10 ft. fans operating at 250 r.p.m., belt driven by motors located above each pair of fans in small motor houses. The fan housings are extended and are provided with doors which may be opened to permit unobstructed entrance of air for operation by natural draft during the winter season. A platform reached by a ladder from the ground serves the 3 motor houses, and an upper gallery is built on the level of the water distributers and the water regulating valves which control the water discharge to each compartment. Any section may be cut off for inspection or cleaning without interfering with the operation of any of the others. The water piping is designed for an additional installation of towers of equal capacity to the left of the present battery. The present equipment is designed to cool 600,000 gal. per hr.

JOHN C. WHITESIDE, recently with the New York Leather Belting Co., has become associated with the Superior Belting Mfg. Co., of Rochester, N. Y., as vice-president and sales manager.

REPORT COMES from the Bureau of Foreign and Domestic Commerce, Washington, D. C., that it has on file specifications for an electric light system in a foreign capital city on which bids are desired on material and installation. Also that catalogs, preferably in Spanish, are desired of gasoline engines suitable for driving sawmill machinery and sugar-cane crushers.

ON OCT. 10, E. Keeler Co., of Williamsport, Pa., celebrated its 50th anniversary with a banquet for employes and sales force at 6 o'clock, followed by an entertainment at the Lycoming Opera House, and presentation of a souvenir to each guest.

During its 50 yr. of industrial activity since 1864, the company has been consistently prosperous and successful, and has secured a large trade and a wide reputation by policy of always advancing the best interest and welfare of its customers.

WITHIN RECENT YEARS, engineers have been striving for higher and higher vacuums, but it is only recently that the feat of obtaining a vacuum 1 per cent higher than the theoretical has been accomplished. A recent test made in the Hydraulic Laboratory of the Wheeler Condenser & Engineering Co., Carteret, N. J., on one of the company's Turbo air pumps, showed vacuums considerably higher than the theoretical for quantities of air up to about 20 cu. ft. of free air per minute when the vacuum fell to the 100 per cent or the theoretical. An explanation advanced by the Engineering Dept. is that the hurling water passing through the pump is subjected to a cooling effect caused by the high vacuum and this reduces the temperature of the water, reduces the vapor tension and increases the vacuum obtainable.

U. S. CIVIL SERVICE COMMISSION announces an examination for junior explosives engineer, on Nov. 18, 1914, to fill a vacancy in this position of the Bureau of Mines at Pittsburgh, Pa., or at other places in the field, at salaries ranging from $1200 to $1500 a year. Duties will be to assist and participate in tests of explosives used in mining and quarrying, and in the demonstration of the use of these explosives in mining and quarrying operations; the duties may involve field work and travel. An educational training equivalent to that required for graduation from a technical school or university of recognized standing, or at least 3 yr. actual experience with mines, or in the manufacture, testing, and use of explosives, is a prerequisite for consideration for this position. Applicants must have reached their twenty-first, but not their forty-fifth, birthday on the date of examination. Each applicant will be required to submit to the examiner on the day of the examination an unmounted photograph of himself taken within 2 yr. Apply for Form 1312, giving the title, Junior Explosives Engineer (Male).

Power Apparatus in Shop and Market

New Ideas In Making, Buying and Selling

Acton Balanced Stop Valve

AUTOMATIC stop valves for steam engine and boiler connections have come in answer to a demand for greater safety in the power plant. Herewith is illustrated a Corliss type of automatic valve recently developed and manufactured by John Acton of Brooklyn. Several arrangements may be employed for operating this valve by hand or automatically, one of which is illustrated here.

The valve is located in the horizontal steam line just inside the wall between the boiler and the engine rooms, and controls both of the main engines.

The valve stem is fitted with a lever A, Fig. 1, in one end of which is a square steel stud and in the other an extension rod. A boss is cast on the valve bonnet which carries a dog, C, pivoted at D. The dog is held in a position to engage the stud by a spring, F, Fig. 1, which is attached to a projection on the dog. A cord is also run to the weight, G, with extensions dropping to within the reach of the operator, Fig. 2.

The angle lever, H, works in bracket bearings and is connected to the lever A by a rod. The weight, J, and dashpot plunger are suspended from the short end of the angle lever by an iron rod.

Each engine drives a speed-limit device consisting of a small throttling governor, the valve disk and seat of which have been removed. The valve stem is cut to a suitable length and operates a relay arm which is pivoted at K, the bottom end of the arm being fitted with a platinum contact point. The 2 contact blocks are connected to the relay coil, L, which, in operating, closes the 110-v. circuit to the magnet M. The magnetism set up in the coil draws the armature away from the weight, G, which on becoming disengaged drops, breaking the circuit at the contact O.

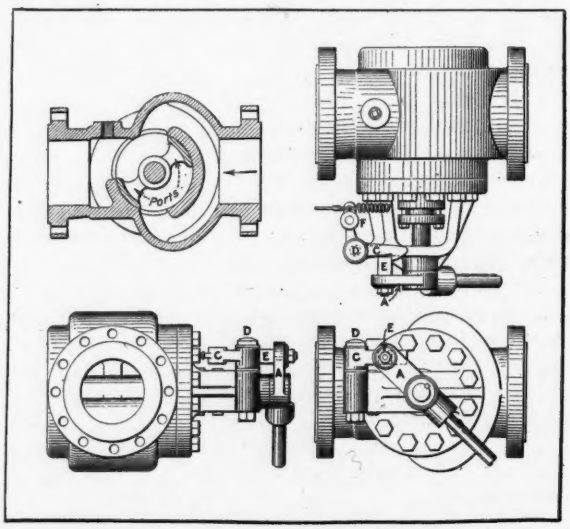


FIG. 1. VIEWS OF ACTON BALANCED CORLISS STOP VALVE

When the weight, G, falls, it pulls the dog, C, away from the catch block, E. This releases the valve stem and the weight, J, pulls the valve forward. The dashpot

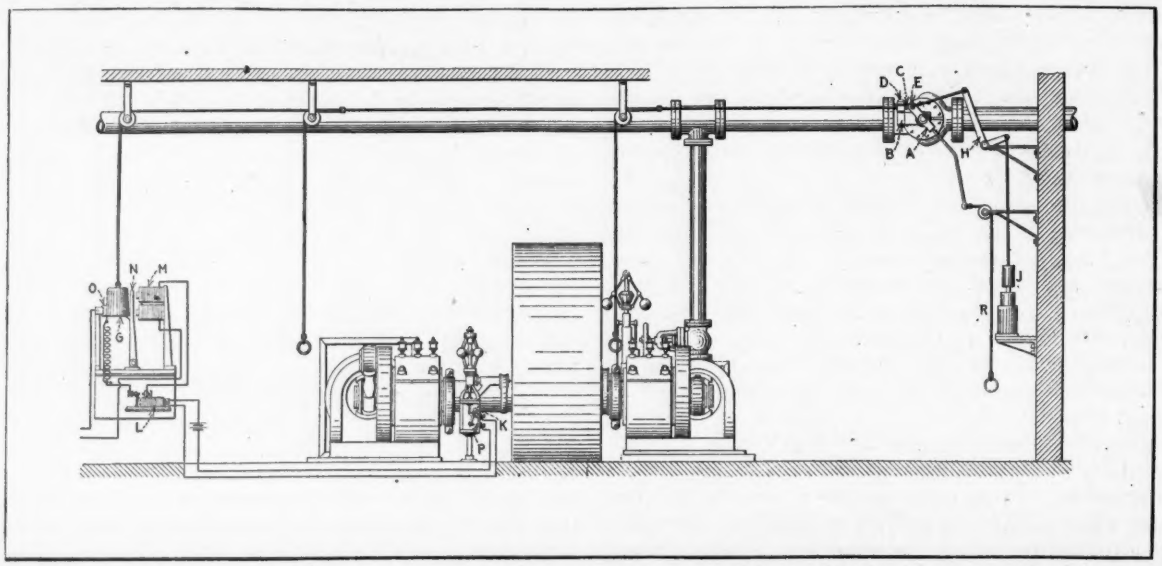


FIG. 2. ELEVATION OF PIPING, SHOWING USE OF ACTON STOP VALVE

below the weight, J, is to prevent the valve from closing with a slam.

The stop valve is closed in the same way when any one of the hand ropes is pulled, releasing the dog from the catch block.

After the valve has operated it is set in an open position by pulling down on the rope, R, which moves the lever toward the right and latches the catch block with the dog, C.

Softening Water Supplies

RECENTLY 2 new processes of water purification have been devised. They are known as the "Permutite" and the "Allagite" processes. Both are based on the properties of certain substances to absorb the hardening elements (lime and magnesia) in the water and to give up to the water a harmless substance, soda.

Permutite is put on the market in the form of white, sometimes granular, sometimes lamellar crystals. This artificial product possesses in a high degree the property of taking up lime and magnesia from aqueous solutions, and replacing them with a corresponding equivalent of sodium in solution.

Softening the water by the aid of permutite is effected by passing it slowly through filter beds of the permutite. In its passage through the permutite the water gives up to the latter its entire contents of dissolved lime and magnesia, in exchange for which the permutite yields up to the water the correct chemical equivalents of soda. Chemically speaking, the sodium atoms combined with the alumina of the permutite are replaced by lime and magnesia atoms.

The permutite is thus gradually changed from a pure sodium zeolite to more of a calcium-magnesium zeolite. When all the replaceable sodium atoms are supplanted by calcium and magnesium atoms, the peculiar property of the permutite is at an end. As soon as the water shows any traces of hardness (which may be detected by the use of ammonium oxalate or by a soap solution) steps are taken to regenerate the permutite.

This regeneration is effected by first freeing the filter from dirt, dust and the like, and loosening its texture by treatment with water, and then passing through it a comparatively concentrated solution of a sodium salt—preferably a solution of common kitchen salt (sodium chloride). There then results the converse reaction to the softening process above described.

In the regeneration process the sodium atoms of the saline solution drive out from the permutite the previously taken up lime and magnesia atoms, and take their place. Thus, in the regeneration, the calcium or magnesium zeolite is again transformed into a sodium zeolite, that can be used again for water softening as at first described.

Kobelt, the inventor of the "allagite" process, found that the so-called "rock glass" or volcanic glass, also, operated in this manner. This, however, does not exist in already available condition, but must first, by a mechanical process, be purified from its inefficient materials. The material, "allagite," consists of a dark brown porous mass with grains about one millimeter in diameter. Chemically it differs from permutite in that, while the latter is a true chemical compound, allagite may be considered as a so-called permanent solution.

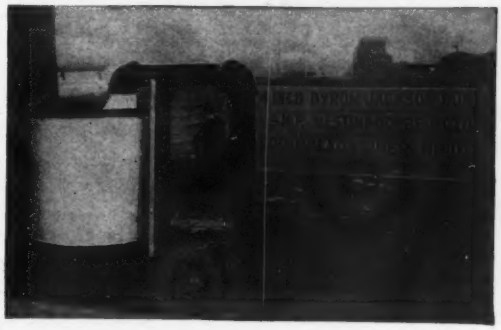
The method of using allagite for softening water is the same as that described for permutite. The same is true as regards its regeneration, which is effected by treatment with a 4 to 5 per cent solution of common salt.

But from another point of view the new softening processes are far in advance of the usual lime and soda method. In textile industries (as silk dyeing), in laundries, etc., these 2 materials do away with difficulties where other processes do not.—Abstract from Municipal Journal.

Novel Use of a Pumping Equipment

A SOMEWHAT novel use of a pumping equipment has been installed in the city of Salinas, Cal. This city is located in the heart of the great Salinas Valley, in the center of a fertile agricultural district whose principal products are milk, butter, cheese, sugar beets, grain and alfalfa.

For a number of years, irrigation carried on in this district has been done by means of gas-engine drive; but in the last few years, electrical manufacturers have conducted an effective campaign in order to convince the farmers of the advantages of motor drive for irrigation purposes.



BYRON JACKSON PUMP AND WESTINGHOUSE MOTOR

The accompanying illustration shows a motor-driven pump installed in the public square in the center of the business district in the city of Salinas, on the main street in full view of all the farmers coming to the city from the surrounding country. They usually tie their horses and park their automobiles at this point and therefore cannot fail to see the installation, which consists of a 5-hp. Westinghouse electric motor direct-connected to a Byron Jackson pump. The pump takes the water from a large tank and pumps it into a reservoir, from which it flows back to the tank. This process is repeated over and over again. The capacity of the pump is 500 gal. per min.

New Oil Testing Set

WITH high voltage oil insulated apparatus, in order to insure successful operation, it is necessary to maintain the dielectric strength of the oil at maximum value. A testing set has recently been developed and placed on the market by the General Electric Co. for determining the dielectric strength of oil.

This set consists of a testing transformer with an induction regulator for voltage control and an oil spark gap. All of the various parts are assembled and mounted so as to form one complete unit, which is compact and neat in appearance and, at the same time, may be conveniently and quickly operated. The set is built for both 25 and 60 cycles.

The transformer has a rating of 3 kv.a. at 30,000 v., but may be operated at 10 per cent above this figure. The high voltage winding is equipped with a voltmeter coil for indicating directly the test voltage. The transformer tank is of drawn seamless steel and the cover is fitted so as to be oil tight, permitting shipment filled with oil. The induction regulator is specially designed

FIG. 1. TYPE K 30,000-V. OIL TESTING SET

for the testing set and allows a variation of the test voltage from zero to maximum. The regulator, as well as the transformer, is arranged for series-parallel connection, making the set suitable for use on 100 or 200-v. circuits. A dial is attached to the top of the rotor shaft of the regulator and is accurately graduated to give readings to read the test voltage in kilovolts.

The set may also be equipped with a small portable voltmeter for reading the test voltage, provision being made on all outfits for mounting an instrument specially designed for the set. This instrument is of the dynamometer type, is very accurate and the scale is graduated to read the test voltage in kilovols.

The oil is tested between flat metal disks, which are located inside the receptacle. One electrode is stationary, and the other has a micrometer adjustment with an adjustable zero index. This permits taking up readily any wear in the gap. The receptacle is designed so that it may be conveniently cleaned. Care has been taken that the quantity of oil required for tests is as small as is consistent with good results. It is estimated that ¾ qt. of oil is sufficient for one sample, allowing 5 tests on clean oil.

The oil receptacle and spark gap are supported by the high voltage terminals of the transformer. By merely turning the receptacle about its horizontal axis, the oil which has been tested may be emptied, being caught by a depression in the transformer cover and flowing away through a pipe.

The receptacle and gap may also be easily removed from the supports, leaving the transformer free for high potential testing of any kind up to 33,000 v.

FIG. 2. OIL SPARK GAP MOUNTED AS A SEPARATE UNIT

This apparatus is also equipped with a small sensitive circuit breaker of novel design, which is attached to the side of the regulator and is likewise specially designed for the apparatus. The set may also be mounted on a truck, making it portable.

The outfit is complete in every essential detail, being all assembled in one unit, which makes it compact and convenient to operate and easy to obtain quick and accurate results. The use of the induction regulator for voltage control produces no noticeable distortion of the e.m.f. wave shape and therefore contributes considerably to the accuracy of the test results.

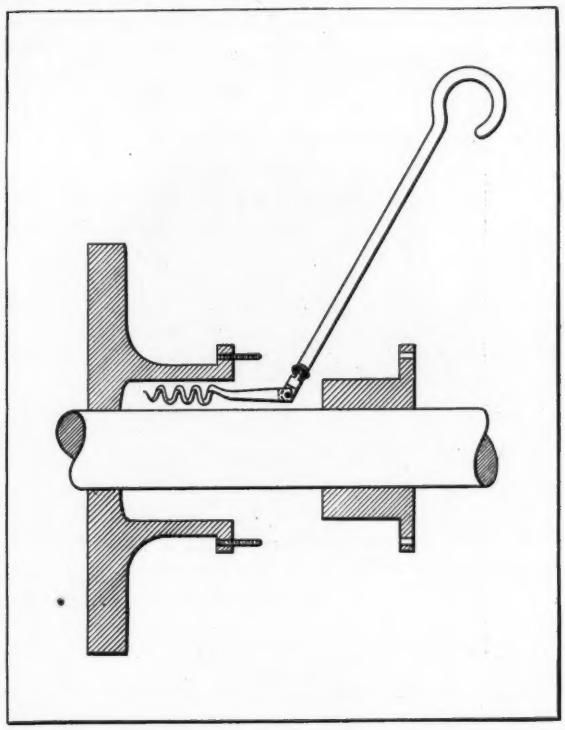
The weight of the 60 cycle set complete is 465 lb., height 30 in., length 24 in., width 17½ in.; the weight of the 25-cycle set complete is 670 lb., height 32 in., length 26½ in., width 20½ in.

AS A DANGER INDICATOR for hot bearings, L. I. T. in Factory suggests the following paint: Equal parts of mercuric iodide and cuprous iodide, ground in linseed oil. This composition dries reasonably rapidly, and when heated begins to turn dark brown, the change of color becoming perceptible at 400 deg., and reaching maximum darkness at 158 deg. On cooling, the paint will return to its original color, but the change is not so rapid as that when heating up. The ingredients are somewhat expensive, and it may be cheaper to paint a streak with this paint across the bearing at the point where the temperature increases should be noticed, then paint the remainder of the bearing with ordinary vermilion paint of the same shade. When the bearing heats, the contrast between the 2 colors will be evident.

This paint should not be applied over other paint, as the indications will not be satisfactory.

Convenient Hook for Removing Packing

REALIZING the annoyance and loss of time caused in removing the packing from Corliss valve stuffing boxes, small valve rods, throttle valves and deep boxes of engines by the old style packing hooks, W. H. Brown has designed what is known as the Universal Packing Hook. From the accompanying illustration, an idea of the general construction of this hook may be gained. As shown, it consists of the packing screw, a modification of the universal joint and the handle. The cut also shows the application of this tool, which is being manufactured and placed on the market by the Universal Tool Co., of Waterbury, Conn.



UNIVERSAL PACKING HOOK

Schoop Process of Metal Spraying

THE Schoop metal spray process of protecting or decorating materials of all descriptions has been in successful commercial use in Europe for several years. It will now be introduced in the United States by the Metals Coating Co. of America, which has acquired the American rights of Schoop and other European inventors and already had the basic patent which controls impacting of metals irrespective of the nature of the apparatus used.

The mechanism of the "pistol" by means of which the metal spray is applied is simple and the weight is small. It weighs only 3½ lb. The cold wire is pulled from a reel into one end of the 3-in. cubical box, continuously and uniformly, at the rate of about 12 ft. a minute, while at the mouth of the short nozzle at the opposite end there issues a continuous hot blast that carries entrained in it, with a velocity of about 3000 ft. a second, a fine spray of molten metal.

The mechanism within the box consists of an air-driven feeding and wire-straightening device which leads the metal into the nozzle core. The wire remains cold and unaltered until it is about ⅛ in. from the nozzle, at which point it undergoes the transformation into spray. The nozzle is directed at the surface which it is proposed to cover from a distance of only 5 or 6 in. The temperature of the molten metal spray at the nozzle varies according to the wire used, from 700 to 2000 deg. F., yet at this trivial distance none of the materials that have been mentioned are injured or altered in the act of being metallized.

The feed apparatus consists of a turbine, operated by the air independently of the blast, which drives friction wheels. A cone of gears permits of any desired regulation of feed. The wire is fed down the core of the inner burner piece at the end of which it passes into the flame zone created by the ignition of the mixture of hydrogen and oxygen, which gases pass simultaneously between the 2 burner pieces. Immediately in front of the flame zone the nozzle discharges a powerful blast of air which completes the disintegration of the wire and causes its particles to be entrained in the expanding gas and air. A supply of compressed air and tanks of commercial oxygen and hydrogen having reducing valves are the only requisites in operating the pistol with any metal in the form of wire.

Power for Panama-Pacific Exposition Exhibits

IN THE Panama-Pacific International Exposition, power for the operation of exhibits will be largely electrical, supplied by the Pacific Gas & Electric Co., but exhibitors of gas engines and oil engines will install a plant in the Machinery Palace to supply direct current for exhibitors' needs.

Information has been published by the Chief of the Department of Machinery Exhibits, which embodies the following points:—No charges to be made for exhibit space, but the space must be properly and economically utilized. All exhibit material is to be consigned to the President of the Exposition, using labels to be furnished to the exhibitor by the Division of Exhibits, which will show the department and space where the exhibit is to be delivered by the Traffic Department of the exposition. This delivery will be made, taking the material from any railway or steamship terminus, at nominal rate, to save the exhibitor work and delay in terminal handling. Traveling cranes will be installed to handle the heavy exhibits, at moderate rate. A one-way freight charge will cover the return of all exhibits over transcontinental lines to the point of origin, and warehouses will be provided at Chicago and other eastern points, where small shipments may be combined into carload lots to be sent direct to the exposition, thus securing carload rates.

A system of mains will furnish water for domestic and drinking purposes, and all water must be purchased on a meter basis, at 40 cents a thousand for ordinary domestic purposes, and at special rates, according to the quantity used, for steam-making, cooling, ice-making, etc.

Electric lighting will be from 60-cycle, 3-phase mains, at approximately 115 v., general illumination of the buildings being cared for by the exposition company. For power service, 60-cycle, single-phase and 3-phase current, at 230 v., will be available, but single-phase motors must not be over 1 hp. for 115 v., and not over 5 hp. for 230 v. In the Palace of Machinery, direct current will be available for power service at 125 and 250 v., during the hours that the exposition buildings are open to the public. No direct current will be furnished for motors or apparatus of larger than 25 hp., and on the 125-v. circuits, no motor larger than 2-hp. will be served.

Gas will be supplied at the rate of $1.50 per thousand up to 50,000 cu. ft. a month, and 80 cents per thousand above that amount, the minimum bill varying from $2.50 to $15 a month, according to the size of meter installed.

Saturated steam at 150 lb. pressure will be furnished in the Machinery Building, and headers and mains for live steam, exhaust steam, drips and drains will be installed by the exposition; but those wishing to use this system must arrange in advance for service. This steam will be sold to exhibitors at practically cost, the rates being fixed as soon as the costs have been determined.

Compressed air at 80 lb. pressure will be available, but the service must be arranged for in advance. The monthly charge will be $4 per hp. of maximum demand of the installation, and in addition, 15 cents per 1000 cu. ft. of free air used, but an exhibitor may provide his own compressor if he so desires.

Working exhibits, which can furnish part of the requirements of the exposition, will be compensated at the regular rates.

Applications for space should be made to the Division of Exhibits, and will be given precedence according to date of receipt. At present, the applicant need state only approximately the amount of space required, and detailed plans will be sent him when final allotments are made; but separate application is necessary for each exhibit in different departments, the location of the exhibit being shown on the final classification.

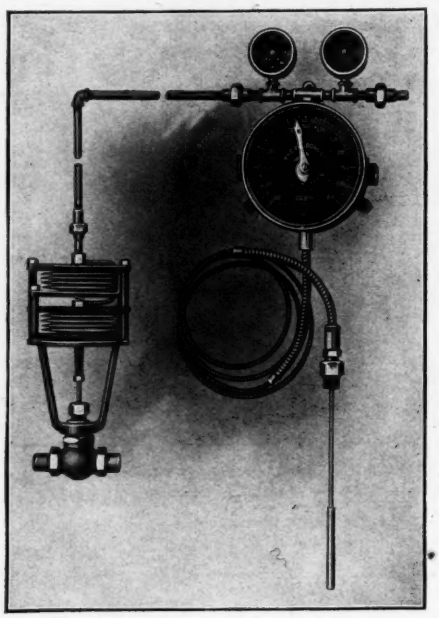
Further information can be secured by writing to the Division of Exhibits, Exposition Building, San Francisco.

New Temperature Controller

A TEMPERATURE controller of simple design, having extreme accuracy and reliability, has been placed on the market. The Foxboro controller, shown in the cut with bulb and diaphragm valve, is a credit to the already complete line of "Foxboro" instruments.

The diaphragm valve is made entirely of metal, having no rubber parts whatever, and is actuated either by pressure or vacuum. The vacuum system of control is better than pressure, as no moisture will accumulate in the piping. Operating by either system, the Foxboro controller automatically closes the diaphragm valve, thereby preventing overheating, if by accident the pressure or vacuum system is out of commission.

The small gage on the right of the controller indicates the amount of pressure or vacuum maintained by the supply system, while the gage on the left indicates when and how much pressure or vacuum is used to operate the diaphragm valve. The small valve inside the controller case which allows pressure or vacuum to operate the diaphragm valve, is itself controlled by the same type of helical spring as used in Foxboro recording thermometers. This means that the most important feature of the regulator has already been tried out by the long experience which the engineers of The Industrial Instrument Co. have had in recording thermometers. The working parts inside the controller case are few and simple.



A NEW TEMPERATURE CONTROLLER

Complete information as to the application and detailed construction of the Foxboro controller may be had from The Industrial Instrument Co., of Foxboro. Mass.

AT ANDOVER, Mass., the new power plant of Phillips Academy is practically completed. Two 75-kv.a. generating units, made by the Ridgeway Dynamo and Engine Co., supply current at 2300 v., either separately or in parallel to the distributing system, and transformers step down to 110 or 220 v. for light and power in the buildings. All wires and transformers are underground.

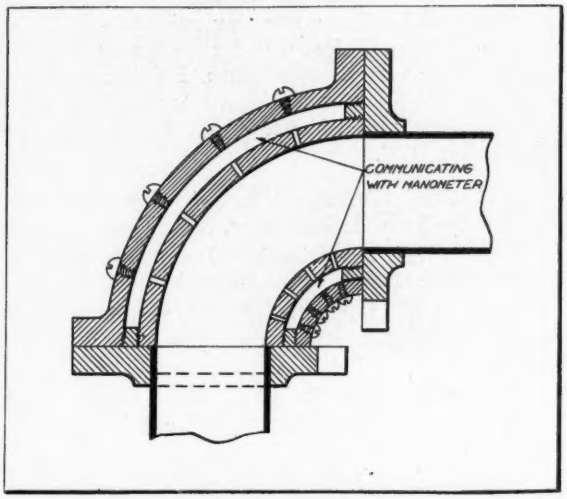
Exhaust steam is used during the winter in a central heating system which supplies all buildings, and furnishes domestic service.

STEAM WHISTLES and whistle valves made by The Wm. Powell Co., of Cincinnati, O., are described and illustrated in a booklet recently issued.

Flow Metering Apparatus

A NEW form of metering apparatus was described by A. M. Levin at a recent meeting of the A. S. M. E. in which the centrifugal pressure is measured as the fluid (steam, air, gas or water) passes through an elbow. This elbow is provided with suitable pressure ports through which the pressures may be transmitted to an ordinary U-tube manometer.

The formulas relating to this flow-bend are of the same form as those applying to the pitot tube, except that there is prefixed a multiplier which depends on the ratio of the diameter or width of the channel to the mean radius of curvature of the bend. Where the density of the fluid remains constant, the expression for the velocity is



METERING BEND

$$Vm = \sqrt{\frac{p}{2D}} \times \sqrt{2gH};$$

Vm = Mean linear velocity;
p = Mean radius bend;
D = Diameter of pipe or width of channel;
g = 32.16;
H = Difference in pressure at outer and inner walls of bend as measured by the manometer and expressed in feet head of the fluid.

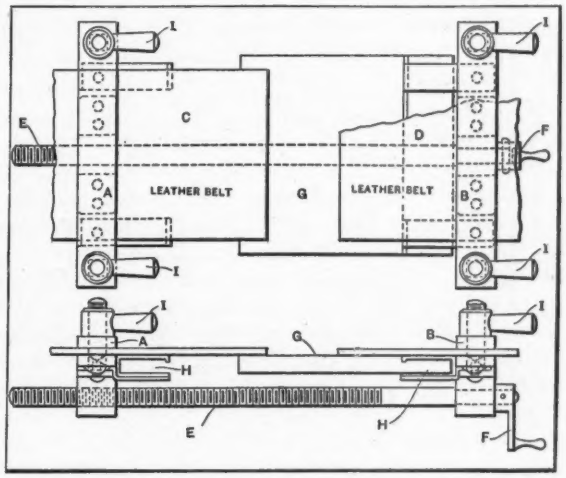
The second term of the expression ($\sqrt{2gH}$) is that ordinarily applying to the pitot tube.

Device for Stretching Belting

IN MACHINERY, Ernest Schwartz describes, as follows, a simple and convenient device for stretching belting preparatory to cutting and lacing.

"It is similar in design to the various devices of its kind on the market today, but is particularly easy to manipulate. In the past I have been using the Gardner & Miller patent belt clamp, which is operated by 2 feed-screws with turnbuckles. This necessitates the use of both hands in tightening. It is also minus the cutting-board arrangement, which has to be supported by hand while cutting; I therefore 'hit upon' the accompanying design.

"The clamps A and B are operated by handle-nuts I, which work up and down on bolts with square shoulders, thus fastening the ends of belts C and D. The belts are then ready to stretch by means of the screw E which has a crank F on its squared end. The crank F is replaced by a wheel with a corrugated rim, which is used in preference to the regular crank when adjusting small belts, as it does not get too much tension on the belts and leaves them in condition for a future adjustment. The cutting-board G is then inserted in compartment H, leaving the belt ready for cutting and lacing."



DEVICE FOR ADJUSTING DRIVING BELTS, EQUIPPED WITH A CUTTING BOARD

Books and Catalogs

THE THERMAL PROPERTIES OF STEAM, by G. A. Goodenough, has been issued as Bulletin No. 75 of the Engineering Experiment Station of the University of Illinois. The bulletin presents a critical discussion of the experimental investigations of the various thermal properties of steam, an outline of the thermodynamic relations that must be satisfied, and finally the development of a general theory of superheated and saturated steam. As a basis for such a theory the well-known Munich experiments on specific volumes and specific heats are taken and properly correlated through the Clausius relation. The assumed characteristic "equation" for steam is shown to fit the experimental points with extreme accuracy, and other tests are given to show the superiority of the equation over Lunde's equation, which has heretofore been employed. The equation for specific heat gives a corresponding close agreement with the Knoblauch and Mollier points. Simple mathematical manipulation leads to explicit expressions for heat content and entropy, and various tests applied show that the values thus deduced are in excellent agreement with the best experimental evidence. The range of temperature through which the theory appears to be valid

extends from 32 to 600 deg. F. for saturated steam. The corresponding upper limit of pressure is above 1500 lb. per sq. in.

The result of the investigation is a formulation of the properties of steam for which the following claims may be urged: 1, absolute thermodynamic consistence; 2, extreme accuracy; 3, simplicity; 4, flexibility; 5, great range of validity.

Copies of Bulletin No. 75 may be obtained gratis upon application to C. R. Richards, Acting Director of the Engineering Experiment Station, University of Illinois, Urbana, Ill.

FROM S. E. HENDRICKS CO., of New York City, has come the 23rd Annual Edition of Hendricks' Commercial Register of the United States, which is a most complete and useful work. Careful revision has been made, many new names being added, titles of identification inserted and duplicates removed. Incorporated with the register is the Assistant Buyer, formerly published by the Sullivan System, to give complete classified lists of manufacturers for the benefit of those who want to buy and sell. The register contains some 1600 pages, about 350,000 names and addresses, and some 45,000 classifications. It gives the names of manufacturers of all kinds of machinery, tools, etc., and is, therefore, useful as a book of reference for manufacturers and engineers. The price is $10, carriage prepaid, and the book can be procured from S. E. Hendricks Co., Inc., Publishers, 3 West 13th St., New York, N. Y.

BURT Oil Filters Exhaust Head and Ventilators is the title that stands out on what is apparently the name plate riveted to a galvanized iron casing. In reality, this is the casing or covering to an attractive and effective catalog of the specialties made by the Burt Mfg. Co., of Akron, O., which begins with a complete discussion of oil filtering, process and filtering materials and a description of the Cross, American, and Warden filters and the Burt filtering system. And continues with a like complete treatise on ventilation of factories and public buildings, showing why a plentiful supply of fresh air is a good investment, and how the Burt ventilators of various types are used to furnish such supply.

Incidentally the value of Burt exhaust heads in saving fuel and boilers is explained. It all constitutes a handsome book of 126 pages which is "easy to read and worth reading."

FROM THE INDUSTRIAL INSTRUMENT Co., Foxboro, Mass., we have received the following: Bulletin No. 85, on the subject of Foxboro indicating gages; Bulletin No. 87, on Foxboro mechanical and electrical time recorders; Bulletin No. 88, on Foxboro recording gages; and a folder relating to Foxboro orifice meters.

THE GENERAL ELECTRIC CO. has just issued an interesting illustrated bulletin, No. 48,014, on mine hoist equipment, which takes up the question of economy of electric drive, and treats of the general subject of underground hoists, their operation and control.

BULLETIN 113 of Yarnall-Waring Co., Chestnut Hill, Philadelphia, gives a list of the largest users of Simplex Seatless blowoff valves.

BUREAU OF MINES has issued the following new publications, only a limited supply of which is available for free distribution: Bulletin 83—the humidity of mine air, with especial reference to coal mines in Illinois, by R. Y. Williams, 1914, 69 pp.; Technical Paper 65—a study of the oxidation of coal, by H. C. Porter and O. C. Ralston, 1914, 30 pp.; Technical Paper 84—production of explosives in the United States during the calendar year 1913, by A. H. Fay, 1914, 13 pp.; Technical Paper 93—quarry accidents in the United States during the calendar year 1913, compiled by A. H. Fay, 1914, 66 pp.; Miners' Circular 16—hints on coal-mine ventilation, by J. J. Rutledge, 1914, 22 pp.; Miners' Circular 19—the prevention of accidents from explosives in metal mines, by Edwin Higgins, 1914, 16 pp.

Applicants are asked to cooperate in insuring an equitable distribution by selecting publications that are of especial interest. Requests for all papers cannot be granted without satisfactory reason. Publications should be ordered by number and title. Applications should be addressed to the Director of the Bureau of Mines, Washington, D. C.

NEW PUBLICATIONS have been received from Ingersoll-Rand Co., 11 Broadway, New York, as follows:

Form 8207, "Little David" Drills for Metal and Wood Boring; illustrated, 36 pp., 6 by 9 in.

Form 8013, ,'Little David" Pneumatic Chipping, Calking and Scaling Hammers; illustrated, 12 pp., 6 by 9 in.

Form 4033, "Little Tugger" Air Hoist for Mines, Contractors, Manufacturing and Power Plants, etc.; illustrated, 8 pp., 6 by 9 in.

Copies of these pamphlets will be sent free on request.

WESTINGHOUSE ELECTRIC DRIVE for flour mills, is described in Folder 4287, in which some curves are given showing the load on a flour mill driven by electric motors. A complete equipment of these mills is given, together with the advantages gained by this method of drive.

Motor-generator sets, utilizing a direct-current generator and an alternating-current motor, are illustrated in descriptive leaflet No. 3742. The advantages of this type of machine and its characteristics are described.

These publications were recently issued by Westinghouse Electric & Mfg. Co.

BULLETIN NO. 46,390, just issued by the General Electric Co., describes that company's direct-current test meter, known as Type CB-5, which combines in one standard several capacities covering a range from light load to full load, and making possible rapid testing since no time is lost in changing standards. The meter is inclosed in a wooden carrying case of half-inch oak, and supplied with a leather carrying strap. Its accuracy is exceptional. It is made for use on 100 to 120 and 200 to 240-v. circuits, measures 14⅛ by 8⅛ by 7¼ in. over all, and the net weight is 21½ lb. The construction is described in detail, and the bulletin contains diagrams of connections.

STEAM SPECIALTIES for power plants and steam heating are illustrated and described in Catalog 21 of W. D. Allen Mfg. Co., 133 W. Lake St., Chicago.

WESTINGHOUSE ELECTRIC & MFG. CO. has issued the following among recent publications:

Electric Drive of Rubber Calenders, Leaflet 3693, deals with the advantages to be gained by the use of electric drive for this class of work, showing a number of illustrations of actual installations.

Glue Pots and Glue Cookers, Folder 4293, shows the method of installing an electrically heated glue pot and glue cooker, and the advantages to be gained from its use.

IN BULLETIN 310, C. J. Tagliabue Mfg. Co., of Brooklyn, N. Y., describes a number of interesting instruments for steam plant use. The detail of the Hohmann type thermometers is shown, and various connectors are arranging these thermometers in different places about the plant; also, the construction and means for connecting flue gas thermometers, pyrometers, vacuum gages of different types, draft gages and temperature controllers.

A novel instrument is the Thermoscope, which is a pocket instrument for analyzing flue gas to determine the percentage of CO_2. It uses inexpensive cartridges instead of liquid, and operates by the drawing out and pushing in of a plunger, which draws a measured quantity of flue gas, then passes it through a caustic soda cartridge, thus producing a chemical reaction which generates heat. The amount of heat thus generated is an index of the percentage of CO_2, and the temperature produced is shown on a mercury thermometer which is graduated to show this percentage. It is a device well worth the careful attention of the engineer who wishes to keep tab on the correctness of the combustion in his furnaces.

BULLETINS NOS. 4500, 4510, 4520 and 4530 describe the new Cutler-Hammer automatic machine tool controllers for use with shunt or compound-wound d.c. motors, adapted for constant or adjustable speed work, with or without interpoles. Increased output and lower cost of production is claimed for this automatic control owing to the ability of the operator to start and stop without leaving his normal position; the possibility of the foreman setting the control at the proper speed for a job and leaving the operator free to start and stop, but unable to change the speed; and the dynamic brake, by which a tool that would otherwise run several seconds after the power is cut off, is brought to rest practically at once by the motor, which acts as a generator and stops the tool. Bulletin 4510 describes automatic machine tool controllers of the plain starting type; Bulletin No. 4520, those of the speed setting type, and Bulletin No. 4530, those of the speed regulating type. Bulletin 6753 describes double-pole diaphragm regulators for d.c. and a.c. motors; Bulletin No. 7131, full magnetic controllers; Bulletin No. 9125, secondary resistance starting rheostats for polyphase slip ring motors; Bulletin No. 9130, multiple-switch starters; Bulletin No. 9135, drum type starters; Bulletin No. 9155, drum reverse switches; Bulletin No. 9320, panel type speed regulators; Bulletin No. 9350, drum reversible crane controllers; Bulletin No. 9355, hoist controllers; Bulletin No. 9359, rope operated drum reverse switch; Bulletins Nos. 9360 and 9365, speed regulators.

The manufacturer of the controllers, etc., is Cutler-Hammer Mfg. Co., Milwaukee.

THE WORLD'S LEADING IMPORTERS are the United Kingdom, Germany and the United States, in the order named, France being fourth and the Netherlands fifth. The United States and the United Kingdom are the world's largest exporters, followed by Germany, France, and the Netherlands. The United States furnishes about 20 per cent of the total imports into the United Kingdom, 15 per cent of those into Germany, 10 per cent into France, 14 per cent into Italy, 65 per cent into Canada, 53 per cent into Cuba, 50 per cent into Mexico, 15 per cent into Argentina, and 15 per cent into Brazil. The Commercial Relations of the United States, a volume of 272 pages, just issued by the Bureau of Foreign and Domestic Commerce, Department of Commerce, contains revised figures showing in detail for the year 1912 compared with the previous year, the articles entering into the trade of each country and the commercial transactions with the United States. This volume should prove valuable to those interested in the foreign trade of the United States and foreign countries. Copies may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., for 40 cents each.

THE PANAMA CANAL number of American Wire Rope News, published by American Steel & Wire Co., 208 S. La Salle St., Chicago, describes the part played by American wire rope in the work of construction and operation throughout the Panama Canal. Illustrations lend further interest to the pamphlet, whose cover design is a map of the Canal.

Trade Notes

WESTINGHOUSE ELECTRIC & MFG. CO. has recently received the following orders for textile machinery:

Cheney Brothers, So. Manchester, Conn., for 616 textile motors and switches for silk looms; Livingstone Worsted Co., Washington, R. I., for a 312-kv.a. waterwheel generator exciter and switchboard, and a number of type CS motors; Princeton Worsted Mills, Trenton, N. J., for 102 loom motors and 43 Type CS motors; Botany Worsted Mills, Passaic, N. J., for 11 Type CS motors; Germania Mills, Holyoke, Mass., for a 500-kw., 625-kv.a. bleeder turbine; Hockanum Mills, Rockville, Conn., for a number of worsted loom motors and switches; Wm. Skinner & Sons, Holyoke, Mass., for several silk loom motors and switches; Habersham Mills, Habersham, Ga., for a 250-kv.a. generator exciter and switchboard; Renfrew Manufacturing Co., North Adams, Mass., for a number of Type CS motors; Ritzer Brothers, Doylstown, Pa., for 19 silk loom motors; Paul Guenther, Dover, N. J., for a 150-kw., direct-current generator; Ludlow Manufacturing Associates, Ludlow, Mass., for 15 Type CS motors, totaling 2075 hp. Hartford Carpet Corporation, Hartford, Conn., for 13 carpet loom motors.

THE RECENT AWARD by the City of Philadelphia for 2 20,000,000 gal. per day steam turbine driven geared centrifugal pumps, operating against a total head of 330 ft., signalizes the radical change now taking place in water works equipment. These pumps are to be built by the De Laval Steam Turbine Co., of Trenton, N. J., who made a duty guarantee of 145,000,000 ft.-lb. per 1000 lb. of steam.

Other orders of a similar nature recently received by the company are: 2 24,000,000 Imperial gallon steam turbine driven geared pumps for the City of Toronto to operate against a total head of 268 ft., and 2 6,500,000 gal. pumps to operate against a total head of 273 ft., for the San Antonio Water Supply Co., of San Antonio, Tex. The City of Toronto also purchased, several months ago, 1 15,000,000 Imperial gallon pump for 260 ft. head, 1 20,000,000 Imperial gallon pump for 106 ft. head, and 1 7,500,000 Imperial gallon pump for 266 ft. head. Other similar installations, consisting of 1 25,000,000-gal. pump against 250 ft. head for the City of Cleveland, Ohio; 1 30,000,000-gal. pump against 90 ft. head for the City of Omaha, and 1 15,000,000-gal. pump against 135 ft. head, for the City of Lynn, Mass., have been made by the company.

The great advantages of the steam turbine driven centrifugal pump are small first cost and low cost of upkeep, together with the fact that only very light foundations and small building spaces are required. These advantages outweigh considerably the somewhat lower duty obtained as compared with the triple expansion pump.

TWO GAS-BLOWING ENGINES of 46 and 84-in. cylinder diameter, and 60-in. stroke, are being manufactured for the Pennsylvania Steel Co., by the Mesta Machine Co., of Pittsburgh, Pa. Gas cylinders and air cylinders are in tandem, the air cylinder being back of the gas cylinder, an arrangement which is commonly adopted by European builders. The engines are of the center crank type of secure rigid construction.

FRICK CO., of Waynesboro, Pa., has established a branch office in Philadelphia, Pa., at 308 No. Vine St., with H. B. Pennington in charge of its line of refrigerating machinery and ammonia fittings.

IN ORDER to keep in closer touch with its customers and clients, the Uehling Instrument Co. has recently issued a notice that its selling connection through the Uehling Sales Co., 95 Liberty St., New York City, has been discontinued. All future correspondence as well as all orders for Uehling economy apparatus, recorders and supplies, should, therefore, be addressed direct to the main office and works, Uehling Instrument Co., Passaic, N. J.

YARNALL-WARING CO., Chestnut Hill, Philadelphia, reports the receipt of an order from the Duquesne Light Co. of Pittsburgh, Pa., for 2 300,000-lb.-per-hr., "Lea" V-notch recording liquid meters for the measurement of condensate in its Brunots Island power plant, having previously installed 3 Lea metors of the same capacity, making 5 meters in all having a total capacity for measuring at the rate of 1,500,000 lb. per hr.

PRACTICAL ENGINEER

Trade-mark, Reg. U. S. Pat. Off.

SEMI-MONTHLY

PUBLISHED ON THE FIRST AND FIFTEENTH OF EACH MONTH.

Subscription price in advance in the United States, Mexico or united possessions, $1.00 a year.

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Address all letters and make all checks and money orders payable to Technical Publishing Co., 537 So. Dearborn St., Chicago, Ill.

Any advertiser is invited to examine our paid subscription lists and Post Office mailing receipts at any time.

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Full page, one year, each insertion, $60.00.

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Advertisements in this section are inserted under regular headings.

No display type allowed, but the first three words may be set in capital letters.

About nine words make a line. Minimum space sold, two lines.

Under classification "Position Wanted," advertisements not exceeding four lines will be inserted once for subscribers free of charge.

All copy should be received at Chicago office 18 days before date of publication.

Circulation of this issue, 22,500.

Technical Publishing Co.
537 S. Dearborn Street
Chicago

Position Wanted

POSITION WANTED—By young man, 19 years old, as fireman or assistant engineer. Experience with steam, electrical and refrigeration machinery. Can start Jan. 1st. References. Clarence Pickett, Pultneyville, N. Y. 11-1-1

POSITION WANTED—As Manager or Superintendent of a steam plant of 600 K.V.A. capacity or less, where efficiency and net earnings is the slogan. 21 years' experience. All references. Will be released about Nov. 1st. Address Box 373, Practical Engineer, Chicago, Ill. 11-1-1

POSITION WANTED—By young man, age 23, as oiler or assistant engineer in power plant. Six years' experience with steam engines and boilers. Holds first class license for Minnesota. Small plant preferred in Minnesota, North Dakota or Iowa. Address E. U. Webster, Beltrami, Minn. 11-1-1

Wanted

BIDS WILL BE RECEIVED up to Tuesday, Nov. 3, 1914, by the town of Mansfield, La., for the furnishing of pumping machinery to be installed in the water pumping plant now in course of construction in said town. Bids must be in the hands of the City Secretary not later than 12 o'clock noon, Tuesday, Nov. 3, 1914. The right is reserved to reject any and all bids. All bids must be accompanied by a certified check for two hundred ($200.00) dollars. Plans and specifications on file and can be had on application to the City Engineer. L. E. Colvin, City Clerk. 11-1-1

WANTED AT ONCE—Two high grade men to take charge of exclusive territories for a well known concern manufacturing power plant specialties. An excellent opportunity for men who have selling records, and a thorough knowledge of power plant equipment. Applications hold strictly confidential. Give details in first letter. Address Box 374, Practical Engineer, Chicago, Ill. tf.

FREE ENGINEERING BOOKS and power plant tools and specialties for securing new subscribers to Practical Engineer. A dandy chance for the engineer with a little spare time, to get some fine premiums. Send for free descriptive circular and terms. Address Practical Engineer, Subscription Department, Chicago, Ill. tf.

WANTED—Resident subscription agents in all cities of 50,000 population, and over. Many of the largest cities still open. An excellent chance for hustlers to turn their spare time into dollars. Practical Engineer, 537 S. Dearborn St., Chicago, Ill. tf.

WANTED—Engineers who have trouble with poor circulation, foaming or priming boilers and accumulation of scale and sediment and leaky tubes to know of our sure remedy for these evils. Write for details to Olson Automatic Boiler Circulator Co., 217 Chamber of Commerce Bldg., Chicago, Ill. 10-1-6

WANTED—A few hustlers to take orders for Zinco Soot Destroyer. Quick sale. No competition. Good proposition. New York Supply Exchange, Ford Bldg., Detroit, Mich. tf.

WANTED—ALL STEAM USERS to have clean boilers without using compounds or chemicals in any form. Write "Otis," No. 317 Norfolk Ave., Buffalo, N. Y. tf.

Help Wanted

MR. ENGINEER—Do you want to add $5.00 to $10.00 a month to your pay with very little effort on your part and without interfering with your present employment? Others are doing it—so can you. Write for proposition and terms today. Box 369, Practical Engineer, Chicago, Ill. tf.

WANTED—Agents on commission to sell our Shaking Grates. We will install grates on trial or put in on test at our expense with any grate made. Address Armstrong Mfg. Company, Springfield, Ohio. tf.

WANTED—Competent Sales Engineer to sell well-known line on commission basis. H. T. Maurel, 604 W. 115th St., New York, N. Y. 10-1-3

For Sale

FOR SALE—24 by 36-in., 100 revolutions, 125-lb. automatic cutoff Conway engine, right hand, shaft 18 ft. 6 in. long with two wheels 12 ft. 2 in. by 26-in. face and 11 ft. 10 in. by 20-in. face. In good condition and can be seen running any time before Nov. 1st. Built by Filer & Stowell Co., Milwaukee. Is as economical as a Corliss. Worcester Lumber Co., Ltd., Chassell, Mich. 11-1-4

MOTORS FOR SALE—The following new, special type, guarantee motors: 4—¼ h.p., 110-60 a.c., 1750 r.p.m.; 2—½ hp., 110-60 a.c., 1750 r.p.m.; 2—1 h.p., 220-60 a.c., 1750 r.p.m.; 3—2 h.p., 220-60 a.c., 1750 r.p.m.; 5—1/6 h.p., 110 volt d.c., 1750 r.p.m.; 6—¼ h.p., 110 volt d.c., 1750 r.p.m.; 3—2 h.p., 220 volt d.c., 1750 r.p.m.; 4—5 h.p., 220 volt d.c., 1750 r.p.m.; 1—7½ h.p., 220 volt d.c., 1750 r.p.m.; 2—10 h.p., 220 volt d.c., 1750 r.p.m. Also a number of small generators, 5 lights and larger. Write and tell us what you need, mentioning this ad. Fidelity Electric Company, Lancaster, Pa., U. S. A. 10-1-3

FOR SALE—Two 10-K.W. Ridgway, 110-125-volt, direct-connected dynamos and engines, with switchboards, $250 each; 10-K.W. General Electric, 110-125-volt, direct-connected dynamo and engine (vertical Marine type) with switchboard, $300; also 125-volt belted generators; 35-K.W. Sprague, $200; 20-K.W. Westinghouse, $150; 11½-K.W. Crocker Wheeler, $125; and smaller sizes. Duzets & Son, 50 Church St., New York, N. Y. tf.

GROBET SWISS FILES are the standard of excellence in files, and have been for over 100 years. We send post paid, as an introducer, 48 files especially adapted for tool makers and machinists on receipt of $5.00. This is a chance to get a set of files you'll appreciate and well get future orders. Montgomery & Co., 101 Fulton St., New York, N. Y. 11-1-1

FOR SALE—At a Bargain. New 5 by 6, 4-cylinder, governor-controlled engine, fully equipped with carburetor magneto. Will sell for much less than cost. Fred Hanson, 570 Prior Ave., St. Paul, Minn. tf.

FOR SALE—50 LINCOLN MILLERS just as taken from the factory at $50.00 each. Send for photo and description. J. L. Lucas & Son, Bridgeport, Conn. 10-15-2

Patents and Patent Attorneys

PATENTS—Send sketch for free search and report. Books on patents and book of reference letters sent free. John S. Duffie & Co., 612 F St., Washington, D. C. tf.

PATENTS—C. L. Parker, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the invention. Handbook for inventors sent upon request. 186 McGill Bldg., Washington, D. C. tf.

PATENTS THAT PROTECT AND PAY. Advice and books free. Highest references. Best results. Promptness assured. Send sketch or model for free search. Watson E. Coleman, Patent Lawyer, 624 F St., Washington, D. C. tf.

PATENTS—H. W. T. Jenner, Patent Attorney and Mechanical Expert, 606 F St., Washington, D. C. Established 1883. I make a free examination and report if a patent can be had, and the exact costs. Send for full information. tf.

"PATENT YOUR INVENTIONS"—Search free when patent applied for. Charles F. Kincheloe, Patent Lawyer, Woodward Building, Washington, D. C. 10-15-6

PATENTABLE IDEAS WANTED—Send for 3 free books. R. B. Owen, 28 Owen Bldg., Washington, D. C. tf.

Educational and Instruction

ENGINEERS' POCKET MANUAL, 175 pages, edited by University of Tennessee, will be mailed every subscriber sending in NEW subscription (not your own) to Practical Engineer. Gilt edges; bound in leather.

Technical Books

ENGINEERS AND FIREMEN—Send 10c in stamps for a 40-page pamphlet containing a list of questions asked by an examining board of engineers. Stromberg Publishing Co., 2238 Pope Ave., St. Louis, Mo. 10-1-6

Miscellaneous

ENGINEERS DO YOU WANT to utilize your exhaust steam for heating or drying purposes, without back pressure on your engine? If so, address Monash Engineering Co., 1413 W. Jackson Blvd., Chicago, Ill. tf.

Sparks From The Advertising Pages

Dr. Wu Ting Fang, former Chinese Minister to this country, in his book—"From America Through the Spectacles of an Oriental Diplomat"—sees advertising in this light:—

> "If I should be asked what is most essential for the successful carrying on of business in America I would say advertising. A business man in America who intends to succeed must advertise in the daily, weekly and monthly papers, and also have big posters in the streets. I do not believe any up-to-date merchant in America fails to do this. Every book and magazine contains many advertisements; sometimes fully half of a big magazine is covered with notices or pictures of articles for sale. Wherever you go the inevitable poster confronts you; and even when you look out of the window of the train you see large signboards announcing some article of trade. The newer the brand the bigger the picture. If, when you get into a street car you look around you will see nothing but advertisements of all kinds and sorts, and if you answer an advertisement you will keep on receiving notices of the matter about which you inquired. Even now I receive letters urging me to take on something or other about which I sent a letter of inquiry when I was in America. At night, if you stroll around the town you will be amazed by the ingenious and clever signs which the alert minds of the trades people have invented, such as revolving electric lights forming the name of the advertiser with different colors, or a figure or shape of some sort illustrating his wares. But even this is not thought sufficient. Circulars are often sent to everyone, making special offers, setting forth forceful reasons why the commodity advertised is indispensable. There are cases where men who started as petty dealers have, after a few years, become millionaires. To show the importance of advertising, I cite the well-known sanitary drink which is a substitute for tea and coffee, and which by extensive advertising in almost every paper published in every country has now become a favorite beverage. The proprietor is now a multi-millionaire and I am told that he spends more than a million dollars a year in advertising."

* * * * * *

The Saturday Evening Post of October 3rd, 1914, has an interesting article on constructive economy by James H. Collins, a subscriber to Practical Engineer. The article is headed: "Turning Round on a Smaller Margin," and treats extensively of power plant economies.

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Relative to the cost of advertising, take the case of "20-Mule Team Borax." Before it was heavily advertised, borax sold at as high as 30 cents a pound. You can buy 20-Mule Team Borax at 15 cents per single pound or 10 cents per pound in five-pound packages. Increased consumption enabling the manufacturer to cheapen cost of production is the result of Advertising.

Reflection*

RECENT ECONOMIC LEGISLATION AND HELPFUL CONTROL OF BUSINESS

BY HARRY A. WHEELER

WITH every passing year I am more and more impressed with the economic value of the "Trade Press." The trade press, highly specialized, technical and progressive, becomes the interpreter and instructor; the eyes, the ears and the brains engaged in a world search for advanced ideas to benefit the varied fields of commercial activity to which it is especially attached.

Your publications, though highly specialized, are yet full of material of general interest, and I speak from personal experience when I say that the man who desires to keep in close touch with the commercial movements of the world will find no medium so satisfactory as that which you represent.

Your publications are technical, but never tiresome, are progressive, but never yellow, and in this last characteristic you stand wide apart from the daily press and from what, for want of a better term, I may call the social periodical press of the country. You cannot afford to become false teachers by advocating that which is economically unsound, even though the project seems at close range to be beneficial to the interests you serve. Neither can you afford to devote all of your influence simply to the treatment of that which makes for the material upbuilding of business in the technical or scientific sense.

My subject is "Reflection," but I desire only to use this subject in emphasis of the fact that the problems which we have today, and which need to be solved by wise men and in a wise way, are really not of today's origin but are the problems of yesterday.

It is not very exciting reading to take the messages of the Presidents of the United States from the time of the civil war to our present day and read them with a view to ascertaining what were the problems of each administration; but it is notable how, especially from the time of Hayes to the present day, we find a similarity of demand threaded through them all for certain changes affecting the business life of the country, and how, step by step, these demands have become more positive until at last they have evolved into lines of definite action; so, while it is said repeatedly that each decade has its own peculiar problems which seem of more importance than any that have gone before, I believe this decade in which we live is working upon the problems of the past which have become our problems in magnified form, more nearly ready for solution, but not in any very great degree different from the problems of the decades from '70 to '80, '80 to '90, or '90 to 1900.

After the close of the civil war and the resulting political contention regarding the exercise of the right of suffrage and resumption of specie payments, political parties began to fasten upon economic questions and treat them in a highly partisan manner, so that within the memory of every man here we find that at no time have we been free from discussion, and from threatened legislation with respect to the tariff, railroad regulation, monetary legislation, trust regulation, labor legislation, restoration of merchant marine, and acquisition of foreign markets. Upon every one of these questions we have of late reached a new point of departure, arising from legislation actually enacted, or to which the dominant party is now committed.

The tariff has always been the weapon of partisan politics. Economists, politicians and business men have never agreed upon its effect. The first class wove into the operation of the tariff all the theories having to do with political economy, which theories have changed with every decade. The second class used the theory of the economist and excited popular prejudice solely for selfish or partisan reasons, and the last class found itself able to discover but one real economic result from a tariff that offered protection, viz.: that apart from its production of revenue for the operation of the government, it lies absolutely underneath the industrial development of the nation, and has held, and now holds American wages far above the wages of the nations with which we compete. The obvious fact is that we are an industrial nation because we have enjoyed a certain amount of protection to our industries. This may have been too high in the past, and may be too low in the present. I am not arguing this phase of the question, but underneath it all, as fair-minded men, and as a nation that will some time come to see the truth without the partisan prejudice that usually clouds the judgment on this subject, we will come to recognize the fact that our method of protection through tariff upon imports has been, and is, economically sound, and in that soundness has made us what we are. In spite of this, it is utterly impossible to declare a flat tariff principle applicable to all lines of industrial activity, and equally impossible that any principle laid down should be continuously operative in point of time.

Until this nation steps aside from the archaic method by which tariff revisions have been made and undertakes a continuous and scientific study of the needs of our industries and the needs of labor, and by co-operation and consultation with business men intelligently recommends to the Houses of Congress what revision shall be made in the interest of revenue production and

*From an address before the Federation of Trade Press Associations.

what in justice to the people, as a whole, we are destined to suffer depression arising from uncertainty and loss to our industrial life, and greater loss to labor through the danger of non-employment.

Here is the business man's opportunity not to secure from Congress an experimental and inadequately equipped commission, as that of 1882, or a Board without recognition and authority, such as Congress permitted Mr. Taft to appoint during his administration, but a commission that shall be nonpartisan, scientific, with appointments for a sufficient number of years to warrant the devotion of time by men who are expert, and who, without other power than that of recommendation, shall yet carry such weight with the business and political interests of the country that recommendations for revision shall not be fraught with the disastrous experiences of the past.

With respect to railroad regulation: After 15 yr. of discussion Congress passed the Interstate Commerce Act in 1887, turned over to the commission thereby provided for a problem of the most technical and far-reaching character, year after year added to the burdens of the commission by the conference of new powers, until it is not surprising that this little group of men are at times well nigh overwhelmed with the responsibilities and burdens placed upon them.

Now pass with me down to trust legislation. That regulation which came to the railroads as a result of the creation of the Interstate Commerce Commission is just as surely coming to business as a result of the creation of the Interstate Trade Commission. Five men are to be appointed by the President, with the concurrence of the Senate, to assume the appalling task of examining into irregularities with respect to the conduct of interstate business. I am appealing to you to support the contention that through the Chamber of Commerce of the United States, or some other thoroughly representative business body, there shall be appointed jointly with the Interstate Trade Commission, a representative group of business men, who, in their own way, and without interference with the affairs of the Commission, shall study the same problems, only from a slightly different viewpoint, and shall, by conference and co-operation, from the very beginning lessen the ill effects which may come from drastic decisions on the part of the Commission, and likewise justify the acts of the Commission when in the public good their conclusions are sane and reasonable with regard to changes in business method.

By way of illustration, there is a competition in business which the law has not yet recognized; viz., the competition of incompetence. It would appear on the surface that incompetence would eliminate itself and hence constitute no menace, but so long as it is a prevalent condition, one incompetent unit in a business, though small, will, so long as it lasts, exercise a disturbing influence upon all of the competing units. The menace of incompetence is not vicious, but ignorant; but the man, who, through ignorance of his costs, throws loss upon an entire trade, is just as guilty of misdemeanor as the man who orders depression of price for the sole purpose of driving out competition, and only co-operation between the practical man of business, the commission seeking to render a public service, and the Department of Commerce, will devise a means for lessening ignorance and thus largely eliminating what to my mind is one of the most dangerous forms of competition.

In the Federal Reserve Act, which resulted from the long continued struggle for monetary legislation, the law itself provides for such a committee, known as the Advisory Committee, and composed of one member elected by the member banks in each regional reserve district. This Advisory Committee is due almost entirely to the original suggestion and persistent effort of the business men of the country exercised through the Chamber of Commerce of the United States, for the bankers were not cordial to this portion of the law and gave little or no assistance toward its adoption; but today I believe it is conceded, not only by the members of the Federal Reserve Board, but by the bankers of the country as a whole, that the safeguard thus provided assures not only competent advice immediately from the several districts in which the reserve banks are located, and available at a moment's notice to the members of the Federal Reserve Board, but will, when the time comes to offer amendments to the law, prove a bulwark of strength to the Federal Reserve Board upon every point on which that Board and the Advisory Committee are agreed.

The legislative campaign in behalf of labor has been growing in force for many years. The appointment of the Industrial Commission by President Wilson in the first year of his administration has as yet borne little fruit because the task assigned to this group of men was a task which only the superhuman could accomplish. I am hopeful that the life of this Commission will be long continued, and that the suggestion which has recently come from them for the formation of auxiliary cooperative committees, representing both the employer and the employed, shall bring about the happy results for which I am contending through cooperation of all the interested factors.

Harking back along the years, if we review the succeeding administrations closely enough, we will find how far we have really advanced with respect to higher ideals in the conduct of our business affairs. Commissions today mean more than they did a quarter of a century ago. They were apt to be resting places for men worn out in political service, or defeated in their effort to continue therein. Today the effort is to constitute our commissions from the ranks of men who have achieved, and yet who are willing to make some sacrifice for the nation's good. The creation of a commission does not endow its members with any wisdom which they did not originally possess, but the cooperation of experience with right purpose will develop much for the National good.